

Volatility Spillover from Indian stock Market to European Stock Markets

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Abstract: The present study is being to analyze the impact of volatility spillover from Indian stock index to European countries stock markets i.e. France, Germany, European countries, UK. The daily observations comprising of closing data of Sensex of Bombay Stock Market, CAC40 of France, DAX of Germany, EURONEXT100 of European Countries and FTSE100 of UK for the period of 10 years i.e. from April 2007 to March 2017 is used for analysis. In order to study the volatility spillover effects of stock index in Indian Market upon European countries stock markets, GARCH (1, 1) model with exogenous variable is applied. The square of the residuals of the ARMA (1, 1) equation applied on European countries Stock Indices are estimated the squared residuals are assumed to be the proxy of volatility in the underlying European countries stock markets.

I. INTRODUCTION

In the era of globalization and liberalization, the capital markets assume a greater importance. The smooth functioning of the capital market depends on the regulators, participants and investors. The Volatility Index (VIX) is a contrarian response indicator that helps to find out when there is too much optimism or fear in the market. When reaction reaches one extreme or the other, the market typically reverses course. The Volatility Index works well in conjunction with other "overall market indicators." Indian market is now comparable to many developed markets in terms of a number of qualitative parameters. Over the past several years the securities market has witnessed a sea change.

In the study, one of the aims is to analyze the impact of volatility from Indian stock index to International stock markets. For this European countries are selected from international stock market.

II. REVIEW OF LITERATURE

Park & Fatemi (1993) measured the linkages between the emerging Pacific-Basin equity markets and three major developed markets. It examined the relative influence of the U.S., U.K., and Japanese markets on each of the seven Pacific-Basin equity markets and the response patterns of these markets to a shock originating in one of the three developed markets. The researchers found the relative importance of these developed equity markets in generating unexpected variations in the stock market returns of each of the seven Pacific-Basin countries.

Booth & Koutmos (1998) examined the interaction between volatility and autocorrelation in index stock returns of four major European stock markets. An extensive array of specification tests showed that the exponential autoregressive EGARCH model (EAR-EGARCH) explained nonlinearities in the first and second moments quite well.

Bala & Premaratne (2004) investigated volatility co-movement between the Singapore stock market (Straits Times Industrial) and the markets of US(Dow Jones Industrial Average), UK(FTSE 100), Hong Kong (Hang Seng) and Japan (Nikkei 225) by using daily returns from 1992 to 2002. The empirical results of this study indicated that there is a high degree of volatility co-movement between Singapore stock market and that of Hong Kong, US, Japan and UK.

Kaur (2004) investigated the nature and characteristics of volatility in Indian stock market for the time period of 1993-2003. In this study, there was mixed evidence of return and volatility spillover between the US and the Indian markets. While S&P 500 exhibited significant positive correlation only with Nifty returns, NASDAQ returns exhibited significant albeit weak positive correlation only with Sensex. The finding of this paper would be useful to investors because the study provided facts of time varying nature of stock market volatility in India.

Bose & Mukherjee (2005) examined the comovement of the Indian stock market with developed markets like US, Japan and other Asian market. The results of this study indicated that structural reforms of the Indian stock markets helped in integrating it with the rest of the world markets.

Goudarzi & Ramanarayanan (2010) examined the volatility of the Indian stock markets and examine the international financial markets turmoil. The study concluded that GARCH (1, 1) model explained volatility of the Indian stock markets. The results of this study was useful for implications for regulatory and policy markets in the Indian stock market

Mulyadi & Anwar (2012) employed GARCH (1, 1) and GARCH-X model to see return and volatility spillover between three stock markets USA, UK, and Greece stock exchange composite. The result of this study

shows that during all period, there are return spillover between three stock markets which is all significant in 1%.

Gupta et al. (2015) aimed to look at the volatility behaviors prevailing in India. Conditional volatility models like GARCH-1(1,1) model, E-GARCH (1,I) model and T-GARCH (1,I) model had been used to analyze the time series. The study reported evidence from all the indices of time varying volatility which exhibited the sign of clustering, high persistence and predictability in India stock market. The results revealed that Indian stock market does not move random and security prices are totally dependent on the past information.

Objectives of the Study

The present study is being to analyze the impact of volatility from Indian stock index to European countries stock markets i.e. France, Germany, European countries, UK.

III. RESEARCH METHODOLOGY

Sample

This study identifies to analyze the impact of volatility from Indian stock index to European countries stock markets i.e. France, Germany, European countries, UK. The daily observations comprising of closing data of Sensex of Bombay Stock Market, CAC40 of France, DAX of Germany, EURONEXT100 of European Countries and FTSE100 of UK for the period of 10 years i.e. from April 2007 to March 2017 is used for analysis. The data is collected from the reliable sources such as Bloomberg, www.yahoo.finance.com and the websites of respective stock indices such as bseindia.com. The nature of the data is time series and the frequency of the time series is daily. The daily closing value is used for the analysis.

The description of the sampling frames includes the population and target population unit. The population of the study includes the stock markets of the International stock markets are shown in Table 1. However the daily data of selected stock markets is collected for the time period of April 2007 up to March 2017.

Table1: Stock Markets and Index of Indian and European Countries

S. No	Country	Stock Market	Indices	Abbreviation
1	India	Bombay Stock Exchange	SENSEX	SENSEX
2	France	French Stock Exchange	CAC40	CAC40
3	Germany	Deutreher Aktien Index	DAX	DAX
4	European countries	European Stock Exchange	EURONEXT100	EURONEXT100
5	UK	London Stock Exchange	FTSE100	FTSE100

Statistical Tools

GARCH (1, 1) model with exogenous variable

In order to study the volatility spillover effects of stock index in Indian Market upon International Stock Markets, GARCH (1, 1) model with exogenous variable is applied. The square of the residuals of the ARMA (1, 1) equation applied on the selected International Stock Indices are estimated the squared residuals are assumed to be the proxy of volatility in the underlying International Stock Markets. The squared residual is treated as a exogenous variable in the GARCH (1, 1) model applied for the sensex returns. In case if the International Markets is opened after opening of the Indian Stock Market the previous day volatility is considered. The GARCH (1, 1) model applied on the sensex with exogenous volatility in International Stock Markets is representing as

$$\sigma_t^2 = \alpha_o + \alpha_1 \mu_{t-1}^2 + \beta \sigma_{t-1}^2 + \gamma \mu_{t-1}^2 I_{t-1}$$

In the above equation the β_3 indicates the spillover effect in the direction of volatility in International stock volatility. The results of volatility spillover effects from selected stock markets on Indian Stock Indices are discussed below for the period of ten years from April 2007 to March 2017.

IV. DATA ANALYSIS & INTERPRETATION

Volatility Spillover from Sensex to CAC40

Sensex index is selected to study the volatility spillover from Indian Stock Market on French Stock Market. To analyze the volatility spillover in the direction of Sensex index as exogenous variable in the equation the volatility in Sensex is estimated with the help of squaring the residuals of ARMA (1, 1) model applied on Sensex returns. The results of GARCH (1,1) Model is shown below for the period of ten years from April 2007 to March 2017 in Table 2.

The results of GARCH (1, 1) as shown above are indicated that the probability value of Sensex Volatility as an exogenous variable is found to be less than 5% level of significance. Thus it can be concluded from the results that there exists significant volatility spillover in the direction of Indian Stock Market to French Stock Market.

In addition to this the coefficient of Sensex volatility is found to be 0.030 which is positive in nature for the period of ten years from April 2007 to March 2017. This indicates in case if the volatility in the Indian Stock Market increases it will have a significantly positive impact on French Stock Index.

Table2: Analysis of Volatility Spillover from Sensex to CAC40

Dependent Variable: CAC40_RETURN				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.000	0.000	2.588	0.009
AR(1)	0.889	0.067	13.144	0.000
MA(1)	-0.912	0.060	-15.170	0.000
Variance Equation				
C	4.57E-06	9.04E-07	5.051	0.000
RESID(-1)^2	0.126	0.012	10.493	0.000
GARCH(-1)	0.829	0.014	57.451	0.000
SENSEX_VOLATILITY	0.030	0.005	5.650	0.000
Model Fitness Statistics				
R-squared	0.001	S.D. dependent var		0.015
Adjusted R-squared	0.000	Akaike info criterion		-5.878
Log likelihood	7676.137	Schwarz criterion		-5.863
Durbin-Watson stat	2.017	Hannan-Quinn criter.		-5.873

Volatility Spillover from Sensex to DAX

Sensex Index is selected to study the volatility spillover from Indian Stock Market on Germany Stock Market. To analyze the volatility spillover in the direction of Sensex index as exogenous variable in the equation the volatility in Sensex is estimated with the help of squaring the residuals of ARMA (1, 1) model applied on Sensex returns. The results of GARCH (1, 1) Model is shown below for the period of ten years from April 2007 to March 2017 in Table 3.

The results of GARCH (1, 1) as shown above are indicated that the probability value of DAX Volatility as an exogenous variable is found to be less than 5% level of significance. Thus it can be concluded from the results that there exists significant volatility spillover in the direction of Indian Stock Market to Indian Stock Market.

In addition to this the coefficient of Nikkei volatility is found to be 0.008 which is positive in nature for the period of ten years from April 2007 to March 2017. This indicates in case if the volatility in the Indian Stock Market increases it will have a significant positive impact on Germany Stock Index.

Table3: Analysis of Volatility Spillover from Sensex to DAX

Dependent Variable: DAX_RETURN				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.000	0.000	4.342	0.000
AR(1)	0.966	0.018	53.056	0.000
MA(1)	-0.978	0.014	-67.838	0.000
Variance Equation				
C	3.22E-06	7.66E-07	4.206	0.000
RESID(-1)^2	0.107	0.011	9.283	0.000
GARCH(-1)	0.857	0.013	64.405	0.000
SENSEX_VOLATILITY	0.021	0.003	6.398	0.000
Model Fitness Statistics				
R-squared	-0.001	S.D. dependent var		0.014
Adjusted R-squared	-0.002	Akaike info criterion		-5.936
Log likelihood	7751.739	Schwarz criterion		-5.921
Durbin-Watson stat	1.906	Hannan-Quinn criter.		-5.931

Volatility Spillover from Sensex to Euronext100

Sensex index is selected to study the volatility spillover from Indian Stock Market on European countries Stock Market for the period of ten years from April 2007 to March 2017. To analyze the volatility spillover in the direction of Sensex index as exogenous variable in the equation the volatility in Sensex is estimated with the help of squaring the residuals of ARMA (1, 1) model applied on Sensex returns. The results of GARCH (1,1) Model is shown in Table 4.

The results of GARCH (1, 1) as shown above are indicated that the probability value of Sensex Volatility as an exogenous variable is found to be less than 5% level of significance. Thus it can be concluded from the results that they are exist significantly volatility spillover in the direction of Indian Stock Market to European countries Stock Market.

In addition to this the coefficient of Sensex volatility is found to be 0.026 which is positive in nature for the period of ten years from April 2007 to March 2017. This indicates in case if the volatility in the Indian Stock Market increases it will have a significantly positive impact on European countries Stock Index.

Table4: Analysis of Volatility Spillover from Sensex to EURONEXT100

Dependent Variable: EURONEXT_RETURN				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.000	0.000	2.671	0.007
AR(1)	-0.586	1.966	-0.298	0.765
MA(1)	0.585	1.968	0.297	0.766
Variance Equation				
C	3.12E-06	6.80E-07	4.582	0.000
RESID(-1)^2	0.134	0.012	10.614	0.000
GARCH(-1)	0.825	0.014	56.679	0.000
SENSEX_VOLATILITY	0.026	0.004	5.706	0.000
Model Fitness Statistics				
R-squared	-0.001	S.D. dependent var		0.013
Adjusted R-squared	-0.002	Akaike info criterion		-6.101
Log likelihood	7966.433	Schwarz criterion		-6.085
Durbin-Watson stat	2.002	Hannan-Quinn criter.		-6.095

Volatility Spillover from Sensex to FTSE100

Sensex index is selected to study the volatility spillover from Indian Stock Market on London Stock Market for the period of ten years from April 2007 to March. To analyze the volatility spillover in the direction of Sensex index as exogenous variable in the equation the volatility in Sensex is estimated with the help of squaring the residuals of ARMA (1, 1) model applied on Sensex returns. The results of GARCH (1, 1) Model is shown below in Table 5.

The results of GARCH (1,1) as shown above is indicated that the probability value of Sensex Volatility as an exogenous variable is found to be less than 5% level of significance. Thus it can be concluded from the results that there exists significant volatility spillover in the direction of Indian Stock Market to London Stock Market.

In addition to this the coefficient of Sensex volatility is found to be 0.011 which is positive in nature for the period of ten years from April 2007 to March 2017 in Table 5. This indicates in case if the volatility in the Indian Stock Market increases it will have a significant positive impact on London Stock Exchange Index.

Table5: Analysis of Volatility Spillover from Sensex to FTSE100

Dependent Variable: FTSE100_RET				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.000	0.0003	0.324	0.745
AR(1)	0.041	0.944	0.044	0.964
MA(1)	-0.066	0.941	-0.071	0.943
Variance Equation				
C	4.75E-06	1.22E-06	3.894	0.000
RESID(-1)^2	0.082	0.009	9.185	0.000
GARCH(-1)	0.891	0.011	76.923	0.000
SENSEX_VOL	0.011	0.003	3.394	0.000
Model Fitness Statistics				
R-squared	-0.001	S.D. dependent var		0.017
Adjusted R-squared	-0.002	Akaike info criterion		-5.523
Log likelihood	-0.001	Schwarz criterion		-5.503
Durbin-Watson stat	-0.002	Hannan-Quinn criter.		-5.516

V. CONCLUDING REMARKS

It can be concluded from the results that there exists significant volatility spillover in the direction of Indian Stock Market to all the selected European stock markets i. e. shown in the Table 6.

Table6: Volatility Spillover from Indian to International Countries

Country	Intercept	RESID(-1)^2	GARCH(-1)	Volatility Spillover
France	4.57E-06 (0.000)	0.126 (0.000)	0.829 (0.000)	0.030 (0.000)
Germany	3.22E-06 (0.000)	0.107 (0.000)	0.857 (0.000)	0.021 (0.000)
European Country	3.12E-06 (0.000)	0.134 (0.000)	0.825 (0.000)	0.026 (0.000)
UK	2.14E-06 (0.000)	0.141 (0.000)	0.812 (0.000)	0.018 (0.000)

The results of GARCH (1,1) with exogenous variable as Sensex returns indicates that the probability value of Sensex volatility as an exogenous variable is found to be less than 5 percent level of significance for all the selected International stock indices. Mulyadi & Anwar (2012) & Gupta et al. (2013) supported the results. It is found in this study that highest volatility spillover of India is from France with 0.030. Thus it can be concluded from the results that there exists significant volatility spillover in the direction of Indian Stock Market to all the selected European stock markets.

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