International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 5, Issue 1
January 2018

Performance of Indian Equity Market and its Stability Nature by Risk-Return Dynamics

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ABSTRACT

This paper evaluates the forecasting performance of a range of volatility models in Value-at-Risk estimation in the context of the Basle regulatory framework using stock index return data from a selection of emerging markets. It extends the current research in these economies by including a range of GARCH models and their long memory extension, in addition to some standard statistical methods often used by financial institutions. The results suggest that models with long memory or asymmetric effects or both are important considerations in providing improved VaR (vector auto regression) estimates that minimise occasions when the minimum capital requirement identified by the VaR process would have fallen short of actual trading losses. In addition, the results highlight the relevance Basel regulatory framework, and of using out-of-sample forecast evaluation methods for the identification of forecasting models that provide accurate VaR estimates.

Introduction

Equity volatility can be defined as the variation observed in returns calculated over the relevant period of time and volatility spillover as the persistence of volatility across international boundaries or over financial assets in active operation simultaneously or in different periods of time. The present chapter concentrates on transnational spillover of volatility and returns in equity markets. There are variety of reasons for the spillover of volatility between international markets but all of them come together to the degree of integration between the concerned economies and hence the markets that are referred to.

This trend towards integration of national economies got a boost after the collapse of the Brettonwoods and the subsequent liberalization of international capital markets in a phased manner. This has led to enormous amount of capital being moved across international boundaries. A major chunk of this is portfolio investment. This has made equity markets interlinked on a scale never seen before and made them responsive to pulses in any other market. Consequently, the benefits of diversification have begun to be questioned and volatility studies have become an integral part of identification of risk as generated in a particular market as a result of adverse foreign market movement. With this background, the present study has built a model of volatility spillover connecting Japan, India and USA. This study is expected to throw light on the behavior of mean and volatility spillover across these markets and identify the risk present in each of these markets that is being generated in the other two. The selection of markets is based on the trend of past studies as well as on the strategical importance of each of the markets. Nikkei and S&P 500 are two of the biggest markets in terms of market capitalization and trading activity. They also operate on either side of the opening of the Indian market thereby making it easy to capture the mutual impact. It will enable to establish transnational spillover of return and volatility without any ambiguity.

Review of Literature

The seminal works of Tobin (1958) and Markowitz (1959) showed that the efficiency of portfolios could be optimized by combining assets based on the correlation in their return.

In a study centered on the abnormal crash of the US stock market in October 1989 and the subsequent ripple effects around the world, King and Wadhwani (1989), examined a 'rational expectations price equilibrium' and a model of contagion between markets as an outcome of rational attempts to use imperfect information about the events relevant to equity value. The result, as interpreted using simple variance across markets and volatility coefficients of Tokyo, London and New York, supported the contagion hypothesis.

Eun and Shim (1989) used a Vector Auto Regression framework to analyze whether, equity movements in one market can be explained by innovations in other markets and how rapidly information gets transmitted from one market to the other.

An investigation exclusively focused on the transmission of stock return and volatility in the North American market was conducted by Karolyi (1995). The study used conditional heteroscedasticity family models along with Vector Auto Regression to assess the transmission mechanism of volatility for the US and Canadian markets for the period from April 1981 to December 1989 using daily data of New York Stock Exchange (NYSE) and Toronto Stock Exchange (TSE). The study found bivariate GARCH model. An extreme value – Vector Auto Regression (VAR) model was used by Booth *et al.*(1997) in a study of the volatility transmission among US, UK and Japanese markets.

Indian stock market volatility

Studies on the volatility spillover of Indian market have been far and few. In one of the earliest studies, Sharma and Kenndy (1977) examined the price behavior of Indian market with US and London markets. The objective of their study was to test the random walk hypothesis by runs analysis and spectral densities for Bombay Variable Dividend Industrial Share Index (BVDISI), New York S&P 425 common stock Index (S&P 425) and the London Financial Times Actuaries 500 (London FTA). The test period covered 132 monthly observations from 1963 to 1973. The study found that the behavior of BVDISI was statistically indistinguishable from that of London FTA and S&P 425.

Based on these tests, the study observed that the stocks on the BVDISI obeyed a random walk and were equivalent in this sense to the behavior of stock prices in more advanced industrial countries.

Hypotheses of the Study

Ho: The risk return premium does not have any effect on the voltility of the market.

Tools used

The study uses models like GARCH, EGARCH, Historical Simulation, EWMA used by NSE Nifty Junior, Nikkei.

Data collection

Daily return is used in the study and the return was found out by taking the log of the difference of index closing prices on successive days and ranges from January 1 2015 to July 2005. Since there are three markets and all of them do not operate on the same day during the entire period, whenever a market was closed for trading for a particular day the return for all the markets for that day have been removed and hence the final number of observations is 2426 though the original number runs from 2547 for S&P 500 to 2642 for Nifty. All the returns are measured in the local currency. Nifty is a free floating index consisting of a well balanced portfolio of 50 common stocks.

For Nikkei and S&P 500 the number of scripts is 225 and 500 respectively. Data for Nifty return was collected from the official website of the National Stock Exchange of India and those for Nikkei and S&P 500 were collected from econstats.com.

Data Analysis

As a starting point of the discussion on the volatility spill over between Nikkei, Nifty and S&P 500, it would be prudent to have a feeling of the movement of the indices over the study period. It would give a primary idea about the response of each market to major market collapses overseas and also to sustained booms. The markets have been indexed to a base of 5000 for easy comparison.

Table:1 Comparison of Nikkei, Nifty and S&P 500 performance is as follows

Parameters	NKR	NR	SPR
Mean	0.007721	0.079532	0.036720
Median	0.003201	0.137692	0.069166
Maximum	7.488904	10.91974	5.732732
Minimum	-7.394275	-15.59416	-6.865681
Standard Deviation	1.474644	1.694858	1.163450
Skewness	0.018850	-0.375880	0.000898
Kurtosis	4.668100	10.50497	5.856090
Jarque-Bera	281.4139	5750.605	824.5621

Note: NKR, NR and SPR stands for Nikkei, Nifty and S&P 500 return.

Nifty has the best average return while S&P 500 is seen to be the least risky market. The normality assumption is rejected for all the three markets conclusively as the Jarque-Bera statistics is quite high. Only Nifty among the three is negatively skewed while the other two has slightly longer right hand tails

Table:2 Test of Stationarity

Indices	ADF	Philips-Perron	KPSS
NKR	-50.3284 (-3.4328)	-50.5839 (-3.4328)	0.3219 (0.7390)
NR	-47.2539 (-3.4328)	-47.2154 (-3.4328)	0.2284 (0.7390)
SPR	-50.0039 (-3.4328)	-50.4042 (-3.4328)	0.2059 (0.7390)

Figures in the parentheses show t values at one percent level of significance

The result shown here is for the return series and all the three measures of stationarity confirm the stationary properties of the return data. Notice here that while the ADF and PP tests have non stationarity as the null hypothesis

Table:3 Correlation Matrix

Indices	Nikkei	Nifty	S&P 500
Nikkei	1	0.027027	0.316011
Nifty	0.027027	1	0.079530
S&P 500	0.316011	0.079530	1

The result shows that there is very little co-movement between the markets as the highest value is the 0.31 between Nikkei and S&P 500. Nifty seems not to be moving in tandem with Nikkei and S&P 500 as the correlation coefficients are at a paltry 0.02 and 0.07 respectively.

Table: 4 Vector Auto Regression (VAR) Frameworks

Parameters	NKR	NR	SPR
NKR(-1)	-0.0989 (-4.7075*)	-0.0400 (-1.5895)	-0.0307 (-1.7521)
NKR(-2)	-0.0477 (-2.3765*)	0.0211 (0.8759)	-0.0038 (0.2276)
NR(-1)	0.0147 (0.8492)	0.0340 (1.6381)	0.0041 (0.2866)
NR(-2)	-0.0145 (-0.8456)	-0.0494 (-2.3924*)	0.0089 (0.6177)
SPR(-1)	0.4176 (16.8887*)	0.2572 (8.6779*)	-0.0094 (-0.4562)
SPR(-2)	0.0701 (2.6740*)	0.0282 (0.8969)	-0.0103 (-0.4703)
C	-0.0071 (-0.2530)	0.0697 (2.0527*)	0.0366 (1.5466)
R2	0.1106	0.0340	0.0021
Adjusted R^2	0.1084	0.0316	-0.0003
F-Statistic	50.1270	14.2144	0.8706

i) Note:NKR stands for Nikkei return, NR for Nifty return and SPR for S&P 500 return,(ii) t values are given in the parentheses

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ISSN 2394 – 3386
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In this case also S&P 500 is seen to be having more influence in terms of the magnitude of its coefficient. None of the coefficients in the equation for S&P 500 are significant at 5% level but the first lag of Nikkei return is significant at 10% level. All these points to the dominant influence the US market is having on the other two markets.

Table:5 Variance Decomposition Analysis

Nikkei				Nifty				S&P 500			
SE	NKR	NR	SPR	SE	NKR	NR	SPR	SE	NKR	NR	SPR
1.39	100	0	0	1.66	4.3	95.69	0	1.16	3.16	0.22	96.6
1.47	89.37	0.1	10.52	1.69	4.3	92.81	3.01	1.16	3.3	0.22	96.46
1.47	89.33	0.12	10.54	1.69	4.17	92.81	3.02	1.16	3.3	0.24	96.45
1.47	89.26	0.12	10.61	1.69	4.16	92.8	3.02	1.16	3.3	0.24	96.45
1.47	89.26	0.12	10.61	1.69	4.16	92.8	3.02	1.16	3.3	0.24	96.45
1.47	89.26	0.12	10.61	1.69	4.16	92.8	3.02	1.16	3.3	0.24	96.45

Note: NKR stands for Nikkei return, NR for Nifty return, SPR for S&P 500 return and SE for Standard Error.

Volatility Spillover

Mean and volatility spillover has been studied using the AR (1) - GARCH (1, 1) model. The mean equation of each of the domestic market has the return of the other two markets individually as explanatory variables and the volatility equation has the residual from the volatility equation of the other two markets individually as explanatory variables. Further, the return and residuals of the foreign markets have been combined in the mean and volatility equation respectively of the domestic market to see if the addition of the second market imparts any additional explanatory power in the equation of the domestic market.

Table:6 Basic model with Garch

Parameters	Nikkei	Nifty	S&P 500
τ	0.0517 (2.0715)	0.1373 (5.3058)	0.0646 (3.5588)
μ	-0.0153 (-0.6907)	0.0790 (3.8498)	-0.0338 (-1.5399)
α	0.0252 (2.6275)	0.1159 (4.2189)	0.0090 (2.5344)
β	0.0728 (6.6673)	0.1185 (6.4798)	0.0648 (6.7390)
γ	0.9169 (74.0378)	0.8429 (39.7728)	0.9303 (93.3784)
Skewness	0.0163	-0.2834	-0.0204
Kurtosis	4.6864	10.4611	5.8597
Ljung-Box Q (6 lags)	9.3281	14.183	22.369
Ljung-Box Q (12 lags)	16.62	32.61	27.809

Nifty will be having the return and residuals of Nikkei as explanatory variable in the mean and variance equations, S&P 500 will be having the return and residuals of Nifty as explanatory variables in its mean and variance equations and Nikkei will be having the return and residuals of S&P 500 as explanatory variables in its mean and volatility equations respectively

Table:7 Spillover Model for the Near Market with GARCH*

Parameters	Nikkei	Nifty	S&P 500
τ	0.0334 (1.4390)	0.1388 (5.5940)	0.0543 (3.0188)
μ	-0.0635 (3.0735)	0.0703 (3.5322)	-0.0518 (-2.3183)
η	0.4334 (18.1339)	0.2356 (12.3574)	0.0657 (5.6892)
α	0.0113 (1.6329)	0.0803 (3.3726)	0.0059 (1.6238)
β	0.0623 (5.7845)	0.1168 (6.3997)	0.0650 (6.4926)
λ	0.9128 (71.3752)	0.8434 (41.1261)	0.9263 (87.9690)
ρ	0.0298 (3.7452)	0.0156 (2.1780)	0.0025 (2.3210)
Skewness	0.0174	-0.1902	0.0076
Kurtosis	4.7708	9.7257	5.9093
L-B (6 Lags)	10.152	13.487	25.15
L-B (12 Lags)	18.053	29.853	31.018

The result supports the hypothesis that a particular market is likely to be influenced by the return and volatility of the market that closed just prior to the opening of the former. Model specification has improved for Nifty while it has worsened for S&P 500. Skewness and Kurtosis are at acceptable levels except for the Kurtosis of Nifty which is again observed at a comparatively high 9.7257.

Table:8 Spillover model with Garch

Parameters	Nikkei	Nifty	S&P 500
τ	0.0294 (1.2641)	0.1354 (5.4987)	0.0529 (2.9394)
μ	-0.0667 (3.1118)	0.0619 (3.1250)	-0.0995 (-4.4380)
η1	0.0228 (1.3935)(I)	0.2052 (10.3207)(J)	0.1125 (7.8198)(J)
η2	0.4313 (17.8703)(U)	0.1258 (5.3277)(U)	0.0481 (4.1027)(I)
α	0.0102 (1.3522)	0.0858 (3.4316)	0.0058 (1.5808)
β	0.0646 (5.5939)	0.1202 (6.4077)	0.0630 (6.4373)
γ	0.9005 (63.7579)	0.8348 (39.5345)	0.9273 (86.3018)
ρ1	0.0061 (2.2772)(I)	0.0223 (2.4634)(J)	0.0008 (0.3705)(J)
ρ2	0.0309 (3.4832)(U)	0.0057 (0.6760)(U)	0.0020 (1.9295)(I)
Skewness	0.0196	-0.1991	0.0070
Kurtosis	4.7570	10.0100	6.0806
Ljung-B0x(6 Lags)	10.7	13.635	24.82
Ljung-B0x(12 Lags)	18.586	30.570	30.347

International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 5, Issue 1
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Table:9 EGARCH for Nifty with Normal Distribution

ARMA	EGARCH	Observations	Coverage	LRuc	LRind	LRcc	Coverage	LRuc	LRind	LRcc
(1,0)	(1,1)	250	94.8	0.0832	0.0343	0.2243	97.8	10.8382*	0.3507	11.3262*
		500	94.8	0.0832	0.6082	0.7983	97.7	12.4853*	0.4435	12.8825*
		1000	95	0	0.8550	0.9576	98.1	6.4725*	0.8032	7.3141**
		1500	95.6	0.7885	1.8835	2.7620	98.3	4.0910**	1.1211	5.2464
(2,0)		250	94.7	0.1860	0.0138	0.3081	97.9	9.2840*	0.5493	9.8758*
		500	94.4	0.7308	1.0696	1.9157	97.7	12.4853*	0.3507	12.8825*
		1000	95.1	0.0212	0.9956	1.1173	98.1	6.4725*	0.8032	7.3141*
		1500	95.7	1.0807	2.1004	3.2691	98.3	4.0910**	1.1211	5.2464
(0,1)		250	94.8	0.0832	0.0343	0.2243	97.9	9.2840*	0.5493	9.8758*
		500	94.8	0.0832	0.6082	0.7983	97.7	12.4853*	0.3507	12.8825*
		1000	95.1	0.0212	0.9956	1.1173	98.1	6.4725*	0.8032	7.3141*
		1500	95.7	1.0807	2.1004	3.2691	98.3	4.0910**	1.1211	5.2464
(0,2)		250	94.7	0.1860	0.0138	0.3087	97.9	9.2840*	0.5493	9.8758*
		500	94.4	0.7308	1.0696	1.9157	97.7	12.4853*	0.3507	12.8825*
		1000	95.1	0.0212	0.9956	1.1173	98.2	5.2251**	0.9535	6.2150**
		1500	95.7	1.0807	2.1004	3.2691	98.4	3.0766	1.3076	4.4165
(1,1)		250	94.6	0.3287	0.0025	0.4422	97.9	9.2840	0.5493	9.8758*
		500	94.4	0.7308	1.0696	1.9157	97.8	10.8382*	0.4435	11.3262*
		1000	95.1	0.0212	0.9956	1.1173	98.1	6.4725*	0.8032	7.3141*
		1500	95.7	1.0807	2.1004	3.2691	98.3	4.0910**	1.1211	5.2464
(1,2)		250	94.7	0.1860	0.0138	0.3087	97.9	9.2840*	0.5493	9.8758*
		500	94.3	0.9889	0.9238	2.0301	97.8	10.8382*	0.4435	11.3262*
		1000	95.1	0.0212	0.9956	1.1173	98.1	6.4725*	0.8032	7.3141*
		1500	95.7	1.0807	2.1004	3.2691	98.4	3.0766	1.3076	4.4165
(2,1)		250	94.6	0.3287	0.0025	0.4422	98	7.8272*	0.6688	8.5365**
		500	94.3	0.9889	0.9238	2.0301	97.7	12.4853*	0.3507	12.8825*
		1000	95.1	0.0212	0.9956	1.1173	98.1	6.4725*	0.8032	7.3141*
		1500	95.7	1.0807	2.1004	3.2691	98.4	3.0766	1.3076	4.4165
(2,2)		250	94.8	0.0832	0.0343	0.2243	97.9	9.2840*	0.5493	9.8758*
		500	94.3	0.9889	0.1816	1.2880	97.7	12.4853*	0.3507	12.8825*
		1000	95	0	0.8550	0.9576	98.1	6.4725*	0.8032	7.3141**
		1500	95.7	1.0807	2.1004	3.2691	98.3	4.0910**	1.1211	5.2464

Table: 9 Historical Simulations

Number of Observations	Nominal Coverage	LR_{uc}		LR_{cc}	Nominal Coverage	LR_{uc}	LR_{ind}	LR_{cc}
s 250	94%	1.9842	17.9864*	20.0944*	98.8%	0.3798	14.0119*	14.4158*
t 500	92.9%	8.2609*	13.3069*	21.7151*	98.4%	3.3066	16.4512*	58.5064*
o 1000	93.9%	2.3877	11.2652*	13.7787*	98.8%	0.3798	14.0119*	13.6137*
r 1500	95%	0	21.9262*	19.0005*	99%	0	16.5035*	15.5155*

Table: 10 Historical Simulations for Nifty Junior

Number of Observations	Nominal Coverage	LR_{uc}	LR_{ind}	LR_{cc}	Nominal Coverage	LR_{uc}	LR_{ind}	LR_{cc}
250	94.7%	0.186	20.1341*	20.4290*	98.7%	0.8306	16.9442*	2.8591
500	94%	1.9842	28.9811*	31.0890*	98.4%	3.3066	23.4441*	19.3983*
1000	95.7%	1.0807	30.1540*	31.3226*	98.8%	0.3798	21.7241*	17.3967*
1500	96.8%	7.7765*	12.9720*	20.8136*	99.2%	0.4337	10.9279*	10.2370*

Table: 11 Historical Simulations for Nikkei

Number of Observations	Nominal Coverage	LRuc	LRind	LRcc	Nominal Coverage	LRuc	LRind	LRcc
250	95.4%	0.1045	3.2216	3.6615	99.1	0.4337	0.1627	0.2853
500	94.8%	0.4337	0.6081	0.7981	99.2	0.3798	0.1285	0.5783
1000	94.9%	0.4337	0.7259	0.8515	99.2	0.8306	0.1285	0.5783
1500	94.5%	0.3798	0.3208	0.9444	98.8	0.3798	0.2915	0.6954

Table: 12 Exponentially Weighted Moving Average

Number of Observations	Nominal Coverage	LRuc	LRind	LRcc
250	99.2%	0.4337	3.8542**	4.3040
500	99%	0	2.8500	2.9920
1000	99.2%	0.4337	3.8542**	4.3040
1500	99.5%	3.0937	3.2189	8.9403**

Table: 13 Exponentially Moving Average for Nifty Junior

Number of Observations	Nominal Coverage	LRuc	LRind	LRcc
250	98.8%	0.3798	9.2103*	7.6269**
500	98.9%	0.0978	9.2272*	7.6468**
1000	98.9%	0.0978	9.2272*	7.6914**
1500	98.9%	0.0978	9.2272*	7.6914**

Table: 14 Exponentially Moving Averages for Nikkei

Number of Observations	Nominal Coverage	LRuc	LRind	LRcc
250	99.5%	3.0937	0.0501	3.1539
500	99.4%	1.8862	0.0722	1.9705
1000	99.3%	1.0156	0.0983	1.1280
1500	99.2%	0.4337	0.1285	0.5783

Findings and conclusions

The present study has attempted an investigation in to the volatility spillover among Nikkei, Nifty and S&P 500. The relation and the approximate influence of one market on the other was analyzed with the help of VAR model and then the volatility spillover from an individual foreign market to the domestic market and combined volatility spillover from the two foreign markets to the domestic market was also examined using the GARCH model. In order to account for the asymmetry present in the markets a similar investigation was made with the EGARCH model.

Checking for volatility and spillover using the conditional volatility models, it was observed that there was across the board spillover of mean among the three markets, whether they were taken in the chronological order of functioning or as a group. The result did not change with EGARCH also. Most of the times mean spillover effect from foreign market was seen to be as great as to shadow its own effect on its mean through the autoregressive term. But there were significant findings in the volatility spillover study. It was found that volatility of domestic market was influenced by the volatility of foreign market that closed immediately prior to the opening of domestic market.

Taking the other two markets together, it was seen that while Nikkei and Nifty followed the same pattern as in the individual models, differed from it in that the volatility of the market was not defined either by volatility of Nifty or Nikkei while it was actively spilling volatility in to Nikkei. The significant conclusion of the study is that the US market acts independently with respect to Nikkei and Nifty and is the most important producer of information that affects the mean and volatility of the other two markets. Between the other two markets, Nifty is observed to be less influential. It is seen to follow the other two markets.

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