ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 8, Issue, 12, pp.43267-43270, December, 2016

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

INTEGRATION OF INDIAN CAPITAL MARKET WITH US CAPITAL MARKET: A VOLATILITY SPILLOVER STUDY

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ARTICLE INFO

Article History:
Received 03rd September, 2016
Received in revised form
24th October, 2016
Accepted 05th November, 2016
Published online 30th December, 2016

Key words:

ADF Unit Root Test, ARCH-LM, GARCH (1,1), Volatility, Capital Market.

ABSTRACT

The financial integration of different markets leads to co-movement of volatilities which further suggests volatility spillover from one market to another. The present study focuses on analyzing the integration between Indian Capital market and US Capital market. Exchange Rate, Crude oil and Gold return has also been considered for the study to see the impact of external shocks on the volatility of the markets. Daily data volumes ranging from January 2008 to October 2016 has been used and ADF Unit root test, ARCH –LM and GARCH (1,1) has been applied. All the variables are found to be non-stationary at level but become stationary after first difference. ARCH-LM test suggested presence of ARCH affect in the mean equation. The study concluded uni-directional spillover of volatility from S&P 500 to Nifty but not vice versa. Previous period's information about return and volatility is found to explain the behavior of Nifty and S&P 500 both, but exchange rate, crude oil, and gold prices are found to affect the volatility of S&P 500 only.

Citation: Dr. Priyanka Ostwal, 2016. "Integration of indian capital market with us capital market: A volatility spillover study", *International Journal of Current Research,* 8, (12), 43267-43270.

INTRODUCTION

One of the major effects of globalization in India is the integration of Indian financial market with the financial markets of other countries.The macroeconomic variables like Gold Prices, Crude oil prices and exchange rate are also said to be integrated with the capital markets which lead to greater movement of funds from one market to another market. This integration also leads to co-movement of the market returns and volatilities. The co-movement between different market and macroeconomic variables suggests volatility spillover from one market to another market. Volatility spillover tells the extent to which the different markets or variables are integrated with each other. The knowledge of integration between the abovesaid variables is of utmost important because of the recent financial as well as currency crises among the emerging markets all over the globe. Because of this integration, the market of one country cannot work in isolation and will be affected by ups and downs of the other markets. Further, the integration between the markets helps the hedgers and speculators to decide their investment strategies which, in turn, help them to arbitrate between different avenues. Globalization in Indian Capital Market leads to movement of funds from Indian Market to the World Market and vice versa. Previous studies have observed that Indian Capital Market is significantly co-integrated with the capital markets of foreign countries especially USA. The movement of exchange rate is also said to be closely integrated with the movement of financial markets of India. Besides this, Gold and Crude oil prices are also observed to explain the behavior of the stock market. On the basis of the aforementioned discussion, the study is focused on analyzing the integration between Indian Capital market with that of US Capital market. Composite Index CNX Nifty and S&P500 Index have been taken as a proxy of the Indian Capital Market and US Capital Market respectively. Foreign exchange rate between USD and INR, Gold and Crude oil prices has been taken as a proxy of the major macroeconomic variables. Nifty Junior has also been chosen for the purpose of this study to incorporate any other remaining variable affecting the Indian Capital Market. This study is divided into 5 segments. First Segment, provides the introduction of the topic and its importance; Segment 2, describes in brief the available literature on the volatility spillover between Different markets and macroeconomic variables; Segment 3, discusses in details the methodology used for the study; Fourth Segment, shows the Analysis of data and its interpretation; and the last Segment, i.e. Segment 5, is dedicated to Conclusion

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Literature Review

Volatility spillover effect has been studied extensively using GARCH models developed by Engel (1982). Some of the studies are discussed as under:

Ezzati (2013) examined the interdependencies and co-movement of volatility between Iran, and five other selected countries i.e. U.S., Germany, Japan, Saudi Arabia and Kuwait. Two stage procedure of GARCH-M was used to analyze the volatility between the selected markets. The frequency of the data chosen was monthly i.e. monthly financial returns from equity, money and foreign exchange market has been considered for analysis. The result of the study showed that the volatility of different markets is interdependent to a significant level and also indicated that financial markets may not be integrated in levels but can be integrated in variance.

Mishra *et al.* (2007) investigated volatility spillovers between the Indian capital market and foreign exchange markets. The findings of the study indicated the existence of bidirectional volatility spillover between the Indian stock market and the foreign exchange market. S&P CNX NIFTY and S&P CNX 500 were found to be an exception of this finding although the study suggested a long term relationship between the two markets and that the markets move in tandem with each other. The results of the study can be used by investors (domestic and international) for hedging and arbitrage purposes as the information flow between these markets and the markets are integrated with each other.

Palakkod Suhail (2012) analyzed the extent of the integration and interrelation betweenCapital, Commodity and Currency markets using the volatility spillover model i.e. GARCH (1,1) approach. The study concluded volatility spillover from currency market to capital market and vice versa. But spillover of volatility could not be proved from commodity market to currency markets.

Koutmos Gregory and Geoffrey Booth (1995), investigated the transmission mechanism of price and volatility spillovers across three major stock markets of world i.e. New York, Tokyo and London. The study used Exponential GARCH model to describe asymmetric impact of market advances and decline. Using daily returns data the study evidenced that volatility spillovers is more pronounced in case of bad news arriving from last market.

Liu and Pan (1997) analyzed the mean return and volatility spillover effects from the U.S. and Japan to four Asian stock markets, including Hong Kong, Singapore, Taiwan, and Thailand. The study used daily data for the period ranging from 1984 to 1991 and suggested that the US Capital market is more influential in transmitting return and volatilities to the other Asian markets under study. Besides this, the study also observed a substantial increase in spillover after October 1987 stock market crash.

Majumder and Nag (2015) studied the return and volatility spillover between the capital market and the foreign exchange market over a period of 10 Years i.e. April 2003 to September 2013. Using Bivariate EGARCH model the study found a significant volatility spillover between the capital market and foreign exchange markets. Dissection of sample period between pre and post crisis revealed that the volatility spillover has strengthen during post crisis period.

Li and Giles (2015) examined the inter linkages between capital markets of USA, Japan and six other Asian markets including China, India, Indonesia, Malaysia, Philippines and Thailand over a period ranging from January 1993 to December 2012. Using asymmetric multivariate generalized autoregressive conditional heteroscedastic (MGARCH) model the study suggested significant volatility spilloverand unidirectional shock from the US market to the Japanese and the Asian markets and also that the volatility spillovers between the aforesaid markets are stronger and bidirectional during the Asian financial crisis.

Objectives of the Study

The main objective of this study is to investigate the extent to which Indian Capital market is integrated with US capital market. To achieve this objective, the following sub objectives have been chosen:

1. To check the data for stationarity
2. To Check the mean equation for ARCH affect
3. To find out the extent of volatility spillover between Indian Capital market and US Capital Market.

Data Collection Methods

The time span for the study ranges from 1st January 2008 to 31st October 2016. Daily closing values of CNX Nifty index and Nifty Junior Index has been taken from official website of National Stock Exchange (nseindia.com) while the daily data for S&P 500 has been taken from Google Finance (https://www.google.com/finance). Exchange rate data has been collected from the official website of Reserve bank of India (rbi.org.in). Crude oil prices and Gold prices data has been collected from MCX website. Daily data for all the variables has been considered for the present study.

Tools Used and Data Analysis

Augmented Dickey Fuller Test

This test is also known as unit root test and is used to check the time series data for stationarity. The test uses an autoregressive model and assumes the existence of a unit root as a null hypothesis. The results of ADF test are presented in Table I.
The result of the ADF test is presented in Table I and suggests that individual time series data is stationarity. Although at level, the null hypothesis (non-stationarity of data) has been accepted as the ADF statistics in not significant at 5%, but the individual time series become Stationary at difference i.e. null hypothesis is rejected even at 1%. After concluding the stationarity of data series, the next step is to check the mean equation for ARCH affect. ARCH-LM model is used to check the ARCH affect.

ARCH-LM Model

ARCH –LM test is performed with the null hypothesis that the mean equation has no ARCH affect. The presence of ARCH affect and Clustering volatility will enable the study to go further with GARCH (1,1) model.

The result of ARCH LM model is presented in table II. It is evident from the table that the null hypothesis that the mean equation has ARCH affect is rejected as the probability value of 0.0235 is less than 5%. Once ARCH affect is proved in the mean equation, GARCH (1,1) model is used to check volatility spillover to and from Indian Capital market and US Capital market.

Table I. Augmented Dickey Fuller Test (ADF Statistics) Series: Nifty, Nifty Junior, S&P 500, Exchange Rate, Crude oil, Gold

	Level			FirstDifference		
Symbol	LAG Length	ADF Statistics	P-Value	LAG Length	ADF Statistics	P-Value
Nifty	0	-0.866703	0.7991	0	-50.11667	0.0001*
Nifty Junior	1	0.253797	0.9758	0	-47.55915	0.0001*
S&P 500	1	-0.096620	0.9480	0	-54.54444	0.0001*
Exchange Rate	0	-0.823397	0.8119	0	-50.97669	0.0001*
Crude Oil	2	-1.419477	0.5742	1	-33.36944	0.0000*
Gold	2	-1.622451	0.4709	1	-34.09581	0.0000*

Exogenous: Constant, Lag Length: Automatic based on SIC, MAXLAG=27
**MacKinnon (1996) one-sided p-values. Denotes rejection of null hypothesis at 5%*
Deterministic Terms: Intercept

Table II. ARCH LM Test

Variable	Coefficient	St. Error	t-Statistic	Prob.
Constant	1.004407	0.178823	5.616753	0.0000*
ARCH	-0.004391	0.019683	0.223061	0.0235*

**Denotes rejection of null hypothesis at 5%*

Generalized Autoregressive Conditional Heteroscadastic (GARCH) Model

GARCH model is used to analyze the transmission of volatility or volatility spillover effect between Indian Capital Market return and US market return. Exchange Rate, Crude Oil Prices and Gold prices are used as external shocks in the GARCH model. To analyze the volatility spillover between the aforementioned variables different orders of AR-GARCH has been evaluated. Since GARCH (1,1) model is better suitable to data series like index return, GARCH (1,1) model has been used for the present study. To examine the volatility spillover the residual from one variable is used as shock emanating from that market and is introduced to the equations of other markets. If the coefficient of the same is significant, the study confirms volatility spillover and vice versa.

GARCH (1,1) model is explained as under:

AR (1) Equation: $Y_t = x_t'\theta + \varepsilon_{t(1)}$

Where Y_t is the return for time period t, x_t is the vector of exogenous variables and εt is the white noise error term. Here, return on daily stock prices and exchange rates are a function of previous period returns on stock indices and exchange rates plus an error term. The other equations for implementing GARCH (1,1) i.e. volatility equations has been explained as under

$$h_{1\,(nifty)} = \omega_0 + \alpha\varepsilon^2_{t-1} + \beta\sigma^2_{t-1} + \gamma_{1(SqResSP500)} + \gamma_{2(SqResNJ)} + \gamma_{3(SqResExR)} + \gamma_4 (_{SqResCrude}) + \gamma_{5\,(SqResgold)} \quad (2)$$

$$h_{1\,(S\&P500)} = \omega_0 + \alpha\varepsilon^2_{t-1} + \beta\sigma^2_{t-1} + \gamma_{1(SqResnifty)} + \gamma_{2\,(SqResNJ)} + \gamma_{3(SqResExR)} + \gamma_4 (_{SqResCrude}) + \gamma_{5\,(SqResgold)} \quad (3)$$

Where:

- h_1 is variance of residual (Error term) derived from equation (1) and is also known as current day's variance or Volatility of nity/ S&P 500.
- ε^2_{t-1} is previous period's squared residual derived from equation (1) and is also known as previous period's return information about volatility and is the ARCH term.
- σ^2_{t-1} represents the previous day's residual variance or Volatility of Return and is also known as GARCH term.

In the equations given above ω_0 should be greater than zero ($\omega > 0$), and α & β should either be greater or equal to zero i.e. $\alpha \geq 0$ and $\beta \geq 0$. The stationary condition for GARCH (1, 1) is $\alpha + \beta < 1$. If this condition is fulfilled, it means the conditional variance is finite.

Table III GARCH (1,1) Test, Spillover Equation No. (2)

Nifty as Dependent

Variable	Coefficient	St. Error	Z-Statistics	Prob.
Constant (ω_0)	1.52E-05	1.23E-06	12.38727	0.0000*
Residual (-1)^2(ARCH)	0.176157	0.012042	14.62873	0.0000*
GARCH (-1)	0.763327	0.016793	45.45638	0.0000*
S&P 500 (R)	3.80E-06	0.000163	0.023360	0.9814
Nifty Junior (R)	0.632358	0.011374	55.59591	0.0000*
Exchange Rate (R)	-0.000468	0.000708	-0.661817	0.5081
Crude Oil (R)	8.84E-07	3.39E-06	0.260848	0.7942
Gold (R)	8.71E-07	1.02E-06	0.857476	0.3912

**Rejection of null hypothesis at 0.05 Level*

Table III as presented above represents the volatility spillover equation no. 2.The result of the test indicates that the previous period return information about volatility (ARCH) and previous period's volatility (GARCH) both explains the behavior of volatility of S&P CNX Nifty. Since the S&P 500 coefficient is not found significant (i.e. P= 0.9814 >0.05), the null hypothesis (The volatility does not spillover from S&P 500 to S&P CNX Nifty) is accepted. Thus, volatility in S&P 500 does not explain the volatility behavior of Nifty. Further, Exchange rate, Crude Oil and Gold Returns are also not found significant and therefore do not affect the volatility of Nifty.

Table IV GARCH (1,1) Test, Spillover Equation No. (3)

S&P 500 as Dependent

Variable	Coefficient	St. Error	Z-Statistics	Prob.
Constant (ω_0)	1.14E-05	8.22E-07	13.83773	0.0000*
Residual (-1)^2	0.381173	0.032095	11.87632	0.0000*
GARCH (-1)	0.614988	0.015696	39.18167	0.0000*
Nifty (R)	-0.000394	2.56E-05	-15.40774	0.0000*
Nifty Junior (R)	0.116548	0.011489	10.14406	0.0000*
Exchange Rate (R)	-0.004155	0.000618	-6.725163	0.0000*
Crude Oil (R)	1.75E-05	2.57E-06	6.795613	0.0000*
Gold (R)	-3.02E-07	7.00E-07	-4.308113	0.0000*

**Rejection of null hypothesis at 0.05 Level*

Table IV presented above reveals that ARCH (Previous period's information about return) and GARCH (Previous period's volatility) both explain the behavior of S&P 500. Further, CNX Nifty is also found to affect the volatility of S&P 500 and thus explains its behavior. Nifty Junior, Exchange Rate, Crude Oil and Gold Return are also found significant and thus can be concluded to affect the behavior of S&P 500.

Conclusion

The present study focused on integration of Indian Capital Market with US Capital Market using a volatility spillover study. Some external factors like Nifty Junior Return, Exchange Rate, Crude Oil and Gold prices are also considered for the study. The Unit root test was conducted to check the data for stationarity and it was found that the data was non stationary at level but becomes stationary at difference. ARCH-LM Test was also run to check whether the mean equation has ARCH affect and it was concluded to have an ARCH affect. Since, the mean equation has ARCH affect, we proceeded to run GARCH (1,1) test and the result of the study suggested a unidirectional spillover of volatility from CNX Nifty to S&P 500. Further, both the series CNX Nifty and S&P 500 are found to be affected by previous period's volatility and information about previous period return. And in the end, the selected macroeconomic variables are found to explain the volatility behavior of S&P 500 but not CNX Nifty.

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