Financial Forecasting Model in Developed and Developing Economies

Tripti Tripathi, Umesh Holani

Abstract*: The study focused on the volatility forecasting in developed and developing share market. The objective of the study was to evaluate the ability of six different statistical and econometric volatility forecasting models in the context of India, Brazil, Japan and US stock market from November 1994 till February 2005 on the basis of four evaluation error measures statistics which are mean absolute error (MAE), root mean square error (RMSE), Theil's U (TU) and MAPE. The monthly data of stock market index of India, Brazil, Japan and US were collected from January 1992 till April 2005 and also monthly data of stock market index, discount rate, consumer price index (CPI), industrial production and foreign exchange reserves of India, Brazil, Japan and US respectively were collected. Then further analysis was done using four forecasting models which were moving average, exponential weighted moving average, multiple regression, GARCH. The study found out that GARCH and MAE forecasting models are superior in developed market as well as developing market like India.

Keywords: ***stock market, developed and developing economies, mean absolute error, root mean square error, Theil's U, MAPE, moving average, exponential weighted moving average, multiple regression, GARCH.***

I. INTRODUCTION

Volatility is a significant factor in capital market. Modeling capital market changes is an area of empirical and theoretical enquiry both by academicians and practitioners. As conception, volatilities are simple and instinctive. It calculates the variances or dispersions about a mean It can also be said that it finds out how the immediate prices of an asset deviates from the past average values. The understanding of volatility has become more significant because of growing association of national markets in currency; commodity and stock with the rest of the world market and existence of ordinary players have given volatility a new property- that of its speedy transmissibility across markets.

Volatility measures the variability in the asset price. Volatility is related with price unpredictability and ambiguity. It is often applied in place of risks that means, if the volatility increases the risk will also increases. It can also be inferred that high instability leads to improper functioning of market leading to market disruption. At the basic level, volatility indicates the strong point of belief behind the movement of a price. Estimation of volatility of the future trend is very difficult as it gets affected by the large number of parameters such as political instability, economic fundamental, government budgets, policies of government, corporate performances etc. By understanding and calculating historical volatilities predictions could be made about the future trend in volatilities.

Emerging Market Economies (Developing Market Economics)

EMEs are considered as transitional, means they are in process of moving towards an open market economy from a closed economy while building responsibility within the system. India and Eastern bloc countries are some of the examples. As an emerging market the country is focusing on an economic reform program that will make it to responsible and stronger economic performance levels, as well as efficiency and transparency in the stock market. For building confidence in the economy an EME will also improve its exchange rate system because a stable local currency helps to build confidence in an economy, especially when foreigners considers to invest. Due to reforms in exchange rate desires of local investors get reduced for sending their capital abroad. Apart from implementing reforms, an EME also receives aid and guidance from large donor countries or world organisations like International Monetary Fund and World Bank. An important characteristic of EME is that of an increase in both foreign and local investment. Increase in investment of a country usually indicates that an economy is able to gain confidence in the local economy. Investment by foreign countries explains that the world has started noticing the emerging market, and when foreign capital flows toward an EME, the injection of foreign capital flows into the local economy will add volume to the country's capital market and long-term investment into the infrastructure. For international investors or developed-economy business, an EME serves as an outlet for extension by serving, for example, a new place for a new plant or for new sources of income. For the recipient country, rise in employment level, refinement of labor and managerial, and transfer and sharing of technology occurs. In the long-run, rise in the production level of EME's which in turn increases its Gross Domestic Product and ultimately lessening the gap between the emerged and emerging worlds.

Developed Market Economies

Typically developed economy refers to a country with relatively high level of economic security and growth. Some common indicators for

Revised Manuscript Received on November 11, 2019.

***** Correspondence Author

Dr. Tripti Tripathi, Post Doctorate Fellow (UGC), School of Commerce and Management, Jiwaji University, Gwalior, India. Email: triptisharma26@gmail.com

Prof. Umesh Holani, Ex-Dean and Chairman, School of Studies in Commerce and Management, Jiwaji University, Gwalior, India. Email: umeshholani32@gmail.com

judging a country's degree of development are standard of living, industrial production level, per capita income and the amount of extensive infrastructure. There are certain other factors also which are used in finding out the development of a country, like Human Development Index (HDI) which measures relative degrees of education, literacy and health.
Volatility in financial market volatility depicts an abnormal view to the market players, educator & policy maker that without uncertainty high returns cannot be gained, as risk less securities provides low returns while if the risk is high it may generate loss for the investors and can represent cost to the overall economy. It can therefore be said that estimation of volatility is a necessary characteristic in most of the financial decisions, be it allocation of asset, pricing of derivatives or management of risk. But then a question arises, for calculation of volatility which model must be considered as there is no distinct solution. As in literature various models of volatility were given and applied and so these different models results into different estimation of volatility. But till now major work is done in developed economies in the area of stocks and forex market.

II. LITERATURE REVIEW

The study of Mandelbrot (1963) and Fama (1965) studied stocks return and their statistical property. On same lines Akgiray's (1989) also not just examines the statistical values but also found out the proof on the capability of predicting ARCH and GARCH models. Where as Pagan and Schwert (1990) found out, that the EGARCH & GARCH model improved with the factors proposed by the method of nonparametric yield significantly rises in explanatory power. Likewise Dimson and Marsh (1990) found out that as compared to regression based or exponential smoothening based methods simple models are superior. Their study has not included popular ARCH models as against this Tse (1991), Tse and Tung (1992) found that in comparison to GARCH models, EWMA models provide better forecasts. Brailsford and Faff (1996) examined capital market of Australia and the results depicted that ARCH model and regression provides far better forecast. West and Cho (1995) for foreign exchange market found that in the long run no model was suitable and in the short run GARCH model was better. The other work were done by Loudon *et al* (2000), Mcmillan *et al* (2000), Yu (2002), Klaassen (202), Vilasuso (2002) and Balaban (2004). As per Indian scenario Varma (1999) examined the unpredictability estimation model comparing GARCH and the EWMA model in the risk management setting.

3.0 OBJECTIVE AND SCOPE

The objective is to find out the capability of six diverse statistical econometric and volatility predicting models in the context of India, Brazil, Japan and US stock market on the basis of four evaluation error measures statistics – MAPE, Theil's U (TU), and Mean absolute error (MAE) .

After finding the error measures statistics, the ranking of the six volatility forecasting models will be done for stock market of India, Brazil, Japan and US. Also will conclude about the best volatility forecasting method for develop and developing economies.

III. METHODOLOGY

4.1 Data Collection

The monthly data of stock market index of India, Brazil, Japan and US were collected from January 1992 till April 2005 from CMIE prowess database. The monthly data of stock market index, discount rate, consumer price index (CPI), industrial production and foreign exchange reserves of India, Brazil, Japan and US respectively were collected from November 1994 till February 2005 from CMIE prowess database from regression forecasting model.
Nonstationarity of the series is checked by Augmented Dickey-Fuller (ADF) test and if series is found nonstationary, the series were converted into stationary series through standard method of the log differences:

$$R_t = \ln(y_t / y_{t-1})$$

Where R_t is monthly continuous returns, y_t is forecasted value of time period t and y_{t-1} is forecasted value of time period t-1.

4.2 Method of Analysis

4.2.1 Augmented Dickey –Fuller test (ADF) – Unit root test.

An Augmented Dickey–Fuller test (ADF), is the test to check unit root in a time series sample. An Augmented Dickey Fuller statistics, used in the test, is a negative number. The greater is the negativity, the strong is the rejection of the hypothesis that there is a unit root at some level of confidence.
Then further analysis is done through following four forecasting models:

1. Moving average
2. Exponential weighted moving average
3. Multiple regression
4. GARCH(1,1)

4.2.2 Moving Average Model

It is a method of customary time series which defines the volatility as the equal weighted average of obtained unpredictability in the past m months.

$$\therefore \sigma_t^2 = \frac{1}{m}\sum_{i=1}^{m} \sigma_{t-i}^2$$

The choice of 'm' is somewhat random and in this study two models 3, 6 months were investigated. In historic mean model the estimate is done on the basis of all the available observations whether old or new equal weights are given which may result into stale price effecting the forecast, this is what adjusted in moving average statistics.

4.2.3 Exponential Weighted Moving Average

In case of exponential smoothing a method of forecasting that gives higher weights to new observation so as to represent the determinate memory of the market. This method adjust the predictions which are made on the basis of the past prediction errors and the prediction is calculated as a weighted average of the immediate past calculated volatility and the values are forecasted for the same period.

$$\sigma_t^2 = \alpha \cdot \sigma_{t-1}^2 + (1-\alpha) \cdot \hat{\sigma}_{t-1}^2$$

Here as smoothing factor is α and is constrained to 0 < α <1. The smoothing factor finds the weights which are given to actual volatility found in the past month which is immediate, as α → 1 which means more immediate observations get higher weight and on the basis of analyst's intuitive judgment α can be chosen.

4.2.4 Multiple Regression

The main principles developed in finding the simple linear regression may be extended to find several explanatory variables.

An example to explain two explanatory variables, where both are continuous. The regression equation is:

$$Y = \alpha + \beta_1 x_1 + \beta_2 x_2$$

It is customary to replace α□ □ with β, and so all future regression equations would be written as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 \ldots\ldots \beta_n X_n$$

4.2.5 GARCH (Generalized Autoregressive Conditional Heteroskedasticity)

Beginning with simple GARCH(1,1) specification:

$$Y_t = X_t'\theta + \epsilon_t$$

$$\sigma_t^2 = \omega + \alpha\epsilon_{t-1}^2 + \beta\sigma_{t-1}^2$$

4.2.6 Forecast Error Statistics

Comparison of the forecasted performances of each model is done using the following error statistic - Mean absolute error (MAE), Root Mean Square Error (RMSE), Theil's U (TU) and MAPE. These are defined as follows:

$$MAE = \frac{1}{n}\sum_{i=1}^{n}\left|\hat{\sigma}_i - \sigma_i\right|$$

$$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(\hat{\sigma}_i - \sigma_i)^2}$$

$$Theil - U = \frac{\sum_{i=1}^{n}(\hat{\sigma}_i - \sigma_i)^2}{\sum_{i=1}^{n}(\hat{\sigma}_{i-1} - \sigma_i)^2}$$

$$MAPE = \frac{1}{n}\sum_{i=1}^{n}\left|(\hat{\sigma}_i - \sigma_i)/\sigma_i\right|$$

In all the above statistics 'n' stand for number of sample forecasts. As these penalize over forecast and under forecast both, so this statistic is also known as symmetric forecast error statistic.

IV. ANALYSIS

5.1 Indian Market

Ranking based on error statistics:

Table : Ranking of models based on error statistics

	MAE	Rank	RMSE	Rank	Theil-U	Rank	MAPE	Rank
MV-3	0.018225	1	0.024809	1	1.27	6	2.27310	3
MV-6	0.021067	3	0.026731	3	1.034	5	15.7425	6
ES-0.5	0.026742	6	0.035429	6	0.83804	3	8.86145	5
ES-0.75	0.025874	5	0.034685	5	0.90187	4	7.68105	4
Regression	0.020237	2	0.025337	2	0.20081	1	0.82837	2
GARCH (1,1)	0.025412	4	0.033114	4	0.25393	2	0.51722	1

5.2 Brazilian Market

Ranking of models based on error statistics

Table 10: Ranking of models based on error statistics

	MAE	Rank	RMSE	Rank	Theil-U	Rank	MAPE	Rank
MV-3	0.035432	1	0.052100	3	0.669	3	7.222396	6
MV-6	0.036912	3	0.051137	2	0.78646	4	6.5215909	5
ES-0.5	0.051252	5	0.0786789	5	1.313269	6	3.503312	3
ES-0.75	0.048454	4	0.0722989	4	1.11498	5	6.160141	4
Regression	0.035866	2	0.046658	1	0.183724	1	0.658705	2
GARCH (1,1)	0.053275	6	0.080054	6	0.230508	2	0.5910947	1

5.3 US Market

Ranking of models based on error statistics

Table 15: Ranking of models based on error statistics

	MAE	Rank	RMSE	Rank	Theil-U	Rank	MAPE	Rank
MV-3	0.008942	1	0.011468	1	1.21	6	7.4260	5
MV-6	0.009957	2	0.0130568	2	1.029	5	9.458	6
ES-0.5	0.01223	5	0.015883	5	0.88871	3	3.9764	3
ES-0.75	0.011528	4	0.014943	4	0.93888	4	7.2455	4
Regression	0.013485	6	0.01745	6	0.24362	2	1.0509	1
GARCH (1,1)	0.010885	3	0.014717	3	0.23899	1	1.5706	2

5.4 Japanese Market

Ranking of models based on error statistics

Table 20: Ranking of models based on error statistics

	MAE	Rank	RMSE	Rank	Theil-U	Rank	MAPE	Rank
MV-3	0.012363	1	0.0161373	1	1.13	6	3.4863	3
MV-6	0.013838	2	0.01833903	2	1.1161	5	6.6567	6
ES-0.5	0.016904	6	0.0226347	6	0.91397	3	5.8202	5
ES-0.75	0.016112	5	0.02150953	5	0.94129	4	4.8174	4
Regression	0.014971	3	0.019848	3	0.22670	1	0.6272	2
GARCH (1,1)	0.015785	4	0.0207375	4	0.23120	2	0.5313	1

V. RESULT AND DISCUSSION

Table 2 presents error statistic. In this table, explanation of actual statistics with the relative rankings of that specific method among the competing model. We can make the observations from the result about the following markets.

5.1 Indian market

On the basis of Theil's-U and MAE the GARCH (1, 1) and Regression models outperform other models in Indian stock market. According to RMSE and MAE the Moving Average and Regression models are superior to the other models in forecasting ability. Then all measures indicate that EWMA is the worst performing model in the Indian stock market.

5.2 Brazilian market

On the basis of Theil's-U and MAE the GARCH (1, 1) and Regression models outperform other models in Brazilian stock market. On the basis of RMSE and MAE Regression model is superior to other models and GARCH (1, 1) the worst performing model. Then all measures indicate that EWMA is the worst performing model in the Brazilian stock market.

5.3 US market

On the basis of Theil's-U and MAE the GARCH (1, 1) and Regression models outperform other models in US stock market. On the basis of RMSE and MAE Moving Average model is superior to other models and Regression is the worst performing model. All measures indicate that EWMA is the worst performing model in the US stock market.

5.4 Japanese market

On the basis of Theil's-U and MAE the GARCH (1, 1) and Regression models outperform other models in Japanese stock market. On the basis of RMSE and MAE Moving Average model is superior to other models. Lastly all measures indicate that EWMA is the poorest performing model in the Japanese stock market.

VI. CONCLUSION AND LIMITATION OF THE STUDY AND SUGGESTION FOR THE FUTURE RESEARCH

On the basis of Theil's-U and MAE the GARCH (1, 1) and Regression models outperform other models in all stock markets and all error statistics measures shows EWMA is the worst performing model in the all stock markets. On the basis of RMSE and MAE Moving Average model is superior to other models in mainly all the stock markets.

Regression model forecasting ability depends upon the various economical variables taken for the forecasting. If these factors do impact the stock market behavior the forecasting ability also improves. Based on worst performance of EWMA we can conclude that considering recent past information of short time period does produce any predictable forecasting advantage but if we go for long term periods in to consideration its forecasting performance can improve.

Indian market is well develop to Brazilian market and it is behaving develop market like US and Japan; we can go for market efficiency check for these market to understand more about them.

Over all we can say GARCH and MAE forecasting models are superior in developed market as well as developing market like India.

REFERENCES

1. Akgiray, V. (1989). Conditional Heteroscedasticity in Time Series of Stock Returns: Evidence and Forecasts. *Journal of Business*, 62, pp.55-80.
2. Agarwal, R. (2000). Financial Integration and Capital Markets in Developing Countries: A Study of Growth, Volatility and Efficiency in the Indian Capital Market. , *mimeo, Institute of Economic Growth, Delhi*.
3. Becker, K., Finnerty, J. and Gupta, M. (1990). The Intertemporal Relation between the US and Japanese Stock Markets. *Journal of Finance*, 45, pp.1297-1306.
4. Brailsford, T. and Faff, R. (1996). An Evaluation of Volatility Forecasting Techniques," Journal of Banking and Finance. 20, pp.419-438.
5. Franses, P. and Dick Van, D. (1996). Forecasting stock market volatility using (nonlinear) GARCH Models. *Journal of Forecasting*, Journal of Forecasting, pp.229-335.
6. Franses, P. and Ghijsels, H. (1999). Additive Outliers, GARCH and Forecasting Volatility,. *International Journal of Forecasting*, 15, pp.1-9.
7. Kraine, J. (2002). Stock Market Volatility. *FRBSF Economic Letter, Western Banking*, 4, pp.2002-2032.
8. Lo and A.C. MacKinlay, "Stock Market Prices Do Not Follow Random Walks: Evidence from a Simple Specification Test," Review of Financial Studies, Vol 1, 1988, pp 41-66.
9. MacKinlay, A. (1988). Stock Market Prices Do Not Follow Random Walks: Evidence from a Simple Specification Test. *Review of Financial Studies*, 1, pp.41-66.
10. Robert, M. (1980). On estimating the expected return on the market: An explanatory investigation. *Journal of Financial Economics*, 8, pp.323-361.
11. Nelson, D. (2019). Conditional heteroskedasticity in asset returns: A new approach. *Econometrica*, 59, pp.347-370.
12. Poon, S. and Granger, C. (2003). Forecasting volatility in financial markets: A review. *Journal of Economic Literature*, 41, pp.478-539.
13. Poshakwale, S. (2002). The Random Walk Hypothesis in the Emerging Indian Stock Market. *Journal of Business Finance & Accounting,*, 29, pp.1275-1299.