IOSR Journal of Economics and Finance (IOSR-JEF)
e-ISSN: 2321-5933, p-ISSN: 2321-5925. Volume 12, Issue 2 Ser. II (Mar. –Apr. 2021), PP 28-32
www.iosrjournals.org

Volatility Prediction through Ewma – A Review of Literature

Dr. Sonal Sharma[1]
[1](*Hansraj College, University of Delhi, India)*

Abstract:
Background: *Volatility is the oscillation in the prices of an asset over a given time span. Volatility has always intrigued researchers for decades and attempts have been made by them to estimate it in order to help all the stakeholders to use it for various grounds. Exponentially weighted moving average (EWMA) model is one of the widely used models in prediction process of any variable.*
Materials and Methods: *Present study is an attempt to present a review of literature related to volatility predictions through EWMA in various markets to study the topic in depth. The study would facilitate the reader to know the performance and usage of the model in the asset market volatility. It will act as a guideline to various stakeholders.*
Conclusion: *Out of the fifteen papers reviewed, EWMA was the preferred choice in five papers. All the five papers surveyed and applied the model on different assets varying from interest rates, foreign exchange rates to various kinds of indices. More research is required on application of the model on individual stocks, commodities, derivatives, etc, to know the robustness of the model across assets. The data for these five papers majorly revolved around USA markets, Indian market and Sweden markets. More tests are required to be conducted on data coming from developing markets as they have different market setups and structures. Being part of the traditional group of models, EWMA still has the beauty of beating the more complex models across assets and markets.*
Key Word*: Volatility, Stock Market, Moving average, Indices*

Date of Submission: 10-03-2021 Date of Acceptance: 25-03-2021

I. Introduction

Volatility, in average semantic is defined to be the fluctuations observed in some phenomena. In financial markets volatility is the degree to which financial prices tend to fluctuate. It may be stated as the standard deviation of the continuously compounded returns of a security with a precise time horizon. Volatility of stock returns have been forecasted since ages, and this forecast has been an input to various stakeholder's decision-making process like to determine value of a derivative, to optimize a portfolio, to manage financial risk and so on.

There are legion classes of models or estimators, which were proposed in the literature for measuring volatility of asset returns. Out of them the exponentially weighted moving average model (EWMA) is one of the models which have been delved into the most. Whether unconditional volatility models are being talked about or conditional volatility models, whether implied volatility models or realized volatility models, scholars essentially have always included EWMA to be part of their comparative studies.

II. Objectives of the study

Just like every other study the present study is also based on some clearly defined objectives. The dominant objective of the current paper is to review the findings of various researchers in respect of various volatility measurements or models for various products in the stock market across lands. This review is done to address the following objectives:

1) To review literature on performance of EWMA as compared to other volatility models.
2) To review the existing literature on performance of EWMA across various products.
3)To review the existing literature on performance of EWMA across countries.
4)Through this study an attempt has been made to explore the interpretations of different researchers on performance of EWMA.

III. EWMA

A moving average is an average of fixed data points which moves forward over time. In calculating the average, it is imperative to understand whether all the data points have equal influence or not. In simple moving average, it is assumed that all data points have equal importance whereas in weighted averages more importance

is given to newer information and less importance to older ones. In EWMA, weights to old information decrease exponentially. The Exponentially weighted moving average method:

$$\hat{\sigma}_{t+1} = \sum_{i=1}^{\tau} \beta^i \sigma_{t-i-1} \Big/ \sum_{i=1}^{\tau} \beta^i$$

is the moving average method with exponential weights. Again the smoothing β is estimated by minimizing the in-sample forecast errors. EWMA discovers smaller shifts in the process studied instead of longer transferals.

IV. Review of Literature

Akigray (1989) probes the daily returns on the CRSP value-weighted and equal-weighted indices for the period from January 1963 to December 1986. The whole sample was divided into four different periods of 6 years each, studying each period separately, since the entire series was not expected to be represented by a stationary proces. He compared the EWMA model with the simple historical average model, ARCH and GARCH models. Using the standard statistical measures, ME, RMSE, MAE and MAPE, the EWMA model was not a good performer as compared to others and the GARCH forecasts was found to be better.

Alexander and Leigh in 1997 mainly focused on examining the covariance matrices that are used for internal Value at Risk (VAR) models, but as part of their main focus they also examined the performance of three volatility forecasting methods: the equally weighted average, GARCH models, the EWMA model. They applied these models on the closing prices of five major equity indices and four corresponding US dollar exchange rates for the year 1996. Using standard statistical evaluation criteria, they came up with mixed results, although the EWMA model was generally preferred for all except very short term holding time spans.

Bluhm and Yu (2001) studied the daily closing auction prices of DAX index at the Frankfurt stock exchange. The period of their study was from January 1988 to June 1999. They compared EWMA with other traditional time series models like historical mean model, four ARCH-type models and a stochastic volatility model as well as the implied volatility model for forecasting the future volatility of the DAX index series. The authors have tested the performance of the different volatility models with reference to their practical use in option pricing and VaR. They use the forecast horizons by considering the applied requirements of volatility forecasts in option pricing and VaR. The evaluation criteria used were mean squared prediction error (MSPE), bounded violations, and the LINEX loss function. The authors concluded that the model rankings were sensitive to the error measurements as well as the forecast horizons. The result indicated that according to MAPE error statistics, EWMA was fourth or fifth ranker depending upon the forecast horizons.

Boudoukh, Richardson and Whitelaw (1997) The authors investigated the historical volatility model, the EWMA model, GARCH and multivariate density estimation (MDE) model. These models were illustrated and compared in an out-of-sample daily interest rate volatility forecasting exercise. The asset tested was the everyday change in the interest rate on three-month treasury- bills. The T-bills considered dated 1983 to 1992. They compared realised and forecasted volatility in two ways. First, they took the difference between each model's volatility forecast and the realised volatility, square this difference, and average it through time. Second, they regress realised volatility on the forecasts and document the regression coefficients and R2 (coefficient of determination). The density estimation and EWMA forecasts were found to be the most precise for forecasting the short-term interest rate volatility.

Brailsford and Faff (1996) compared eight volatility models, namely, EWMA model, random walk model, historical mean model, moving average model, exponentially smoothing model, a simple regression model, two standard GARCH models and two Glosten-Jagannathan-Runkle (GJR) asymmetric GARCH models. Data from 1974 to 1985 was used to estimate various model parameters and then these parameters were applied to later data, from 1986 to 1993, thus, forming out-of-sample forecasts for the Australian market index. The commonly used error statistics were calculated like ME, MAE, RMSE, etc. According to their results, no single model came out to be a clearly superior model across the four error measures. The various model rankings were found to be sensitive to the error statistics used.

Brooks and Persand (2003) The authors in 2003 evaluated 13 models viz., random walk model, long-term mean model, short-term moving average (MA5), long-term moving average (MA100), linear regression with one lag (AR1), linear regression with AIC lags (ARAIC), GARCH(1,1), GJR(1,1), EGARCH(1,1) short exponentially weighted moving average (EWMA5), long exponentially weighted moving average (EWMA100), GARCH with t-distributed errors and multivariate GARCH. These models were applied on three assets namely, the FTSE All Share Total Return Index, the British Government Bond Index and the Commodities Price Index, as well as an equally weighted portfolio containing these 3 assets. The authors used mean squared error (MSE), mean absolute error (MAE), and proportion of over-predictions to evaluate accuracy of the volatility forecasts by different models. In the 1-day forecast horizon category, the random walk model produced roughly equal number of over-and under-predictions of realized volatility, whereas all other models overpredicted volatility on average 70% of the time, except the 2 EWMAs. No clear winner emerged at the 1-day horizon, with different

models being preferred for each series. Some models, i.e. the random walk, EGARCH, and to a lesser extent the EWMA models, were poor performers irrespective of both the series on which they were estimated and the loss function used to evaluate their forecasts.

Ding, J., & Meade, N. (2010) tested the set of return time series selected from FX rates, equity indices, equities and commodities and defines a few volatility scenarios that favour either GARCH or Stochastic Volatility (SV) technique. Scenarios were defined by the doggedness of volatility (its robustness to shocks) and the volatility of volatility. Forecasts are churned out from SV, GARCH and Exponentially Weighted Moving Average (EWMA) volatility models. In high volatility of volatility, SV models prophesy were more accurate whereas in medium volatility of volatility, EWMA is streets ahead regardless of the volatility generating process. The author concluded that sketchily, the real series come from the medium volatility of volatility scenarios where EWMA forecasts are consistently precise. The robust structure of EWMA seems to contribute to its greater forecasting accuracy than GARCH model.

Ederington and Guan (2000) Ederington and Guan compared the historical variance model, the EWMA, the GARCH (1,1) and EGARCH models and then proposed a simple nonlinear least squares model. They considered five forecast horizons. While more complex models, which allowed a more flexible weighting pattern than the exponential model forecast better on an in-sample basis, because of the suplemental estimation error introduced by additional parameters, they forecast poorly out-of-sample. With the oddity of GARCH models, they institute that models based on absolute return deviations by and large forecast volatility a cut above than otherwise equivalent models based on squared return deviations. Amongst the most popular time series models, they found that GARCH (1,1) generally provided better forecasts than the historical standard deviation and exponentially weighted moving average models.

Kumar, (2006) considered Nifty and forex closing prices for the period from June 1990 to December 2005 for evaluating the performance of 10 volatility forecasting models. These models include the random walk model, historical mean model, moving average (five) models, simple regression model, exponential weighted moving average model and various simple and higher order GARCH frameworks. The authors used the traditional forecast errors to compare various models' performance. Based on Theil-U and MAE, GARCH models were the best in both the stock market and the forex market. On the basis of RMSE, EWMA was the best. All the forecast errors indicated the historical mean model to be the poorest performer in both the markets. According to the asymmetric forecast error statistics only random walk model provides unbiased forecast.

McMillan, Speight and Apgwilym (2000) The authors analysed the forecasting performance of UK (Financial Times-Actuaries) FTA All Share index from 2nd January 1984 to 31st July 1996 and (Financial Times-Stock Exchange 100 index) FTSE 100 stock index volatility from 1st January 1969 to 31st July 1996. The price returns were calculated at the monthly, weekly and daily frequencies. Both the symmetric and asymmetric loss functions were used to evaluate the performances of the 10 models namely: historical mean, moving average, RW, exponential smoothing, EWMA, simple regression, GARCH, TGARCH, EGARCH and component-GARCH models. According to the authors, performance of GARCH and EWMA was similar across measures and series. Under the symmetric loss category, results suggest that the random walk models provides superior monthly volatility forecast. The ME, RMSE and MAE statistics for both the indices sampled at the monthly frequencies, unadjusted and adjusted for the 1987 crash respectively were reported. The ME statistics signaled that all models overpredict volatility for the twin series, with the sole exception of the random walk. Under the other frequency categories, GARCH, moving average and exponentially smoothing models provide slightly superior daily volatility forecasts. When asymmetric loss is considered, and penalizing over-predictions more heavily the random walk is preferred. However, if under-predictions are penalized more heavily than the historical mean is chosen for the forecasting of daily FTA and FTSE volatility, while exponential smoothing is preferred for forecasting weekly FTSE volatility.

Nilsson, C. (2017) evaluated EWMA with five GARCH specifications namely: GARCH, IGARCH, GJR-GARCH, EGARCH and APARCH by taking daily return observations from the Swedish Stock market index OMXS 30. The models were compared on the basis of their ability to predict one day ahead volatility and value-at-risk. The author concluded that EWMA cannot be a recommendation for either forecasting volatility or VAR. The best model for forecasting volatility came out to be APARCH according to the study.

Pan and Zhang (2006) The authors investigated 19 models namely: the historical mean model, four moving average models (MV1 to MV4, moving through 21 days, 62 days, 120 days and 250 days respectively), an EWMA, a random walk model, three GARCH models, three GJR models, three EGARCH models and three APGARCH models under three distributions. The tests were performed on the Shanghai stock exchange composite index (SHZH) and Shenzhen stock exchange composite index (SZZH) daily closing prices for the period from 2000 to 2004. Standard statistics measures were used to evaluate the performances of the models. The authors concluded that for the Shenzhen stock market, traditional method proved to be superior, especially the moving average model. For the Shanghai index the GARCH-t model, APARCH-N model and moving average models were favoured under different criteria. No single model performed consistently superior under

all the criteria. EWMA's rank was 7th, 16th, 6th and 17th according to MAE, RMSE, MME(U) and MME(O) respectively, indicating the model to be an average to worse performer.

Tse (1991) conducted the study for the period from 1986 to 1989 on the stock returns from the Tokyo Stock Exchange. The author compares EWMA model with a benchmark value, a naïve forecast and ARCH/GARCH forecast. Based n the traditional error statistics used in the literature the author concludes that the EWMA is the best performer amongst all the models tested.

Walsh and Tsou (1998) compared historical volatility model, an improved extreme-value method (IEV), ARCH/GARCH class of models and a EWMA model of volatility. The data used included the three price indices collected the SIRCA database for every five minutes from 1 January 1993 to 31 December 1995. The forecast errors were then compared using four loss functions: mean squared error (MSE), root mean squared error (RMSE), mean absolute error (MAE) and the MAPE. The authors suggested the EWMA to be the best performer closely followed by appropriate GARCH specification.

Yu (2002) Yu's study gauges the performance of nine alternative models by using daily New Zealand data on stock prices from the period 1980 to 1998. The nine models used includes the random walk model, the historical average model, moving average model, simple regression model, exponential smoothing, EWMA, ARCH, GARCH and the stochastic volatility model. These models were evaluated using the RMSE, the mean MAE, the Theil-U statistics and the LINEX loss function. The RMSE statistics witnessed that the SV model provided the immensely accurate forecast. The simple random walk model was not found to be the greatest forecaster according to RMSE. The author concluded that the SV model was the best performer according to all the error statistics. According to none of the measures the EWMA model proved to be the best performer, as compared to previous studies in the literature.

V. Conclusion

Volatility is the fluctuations in the prices of a variable over a period of time. Volatility has always intrigued researchers for decades and attempts have been made by them to estimate it in order to help all the stakeholders to use it for various impetus. Exponentially weighted moving average (EWMA) model is one of the widely used models in prediction process of any variable. A moving average is an average of fixed data points which moves forward over time. In calculating the average, it is imperative to understand whether all the data observations have equal influence or not. In simple moving average, it is conjectured that all data observations have equal importance whereas in weighted averages more importance is given to newer information and less importance to older ones. In EWMA, weights to old information decrease exponentially. Through the present study an effort was put to review the application of EWMA model as compared to other volatility prediction models and across different assets and boundaries. EWMA has been part of the extant literature available on prediction volatility of different assets. Out of the fifteen papers reviewed, EWMA was the preferred choice in five papers. All the five papers surveyed and applied the model on different assets varying from interest rates, foreign exchange rates to various kinds of indices. More research is required on application of the model on individual stocks, commodities, derivatives, etc, to know the robustness of the model across assets. The data for these five papers majorly revolved around USA markets, Indian market and Sweden markets. More tests are required to be conducted on data coming from developing markets as they have different market setups and structures. Being part of the traditional group of models, EWMA still has the beauty of beating the more complex models across assets and markets.

References

[1]. Akigray, V. Conditional Heteroskedasticity in Time Series of Stock Returns: Evidence and Forecast. Journal of Business. 1989; (62): 55-80.

[2]. Alexander, C.O. and Leigh, C.T. On the Covariance Matrices used in Value at Risk Models. The Journal of Derivatives. 1997; 4(3): 50-62.

[3]. Bluhm, H. H. W. and Yu, J. Forecasting Volatility: Evidence from the German Stock Market. International Conference on Modelling and Forecasting Financial Volatility. 2001.

[4]. Boudoukh, J., Richardson, M. and Whitelaw, R.F. Investigation of a Class of Volatility Estimators. The Journal of Derivatives. 1997; 4(3): 63-71.

[5]. Brailsford, T.J. and Faff, R.W. An Evaluation of Volatility Forecasting Technique. Journal of Banking and Finance. 1996; (20): 419-38.

[6]. Brooks, C. and Persand, G. Volatility Forecasting for Risk Management. Journal of Forecasting. 2003; (V22): 1-22.

[7]. Ding, J., & Meade, N. Forecasting accuracy of stochastic volatility, GARCH and EWMA models under different volatility scenarios. Applied Financial Economics. 2010; *20*(10): 771-783.

[8]. Ederington, L. and Guan, W. Why are those Options Smiling? Working Paper Series, University of Oklahoma Center for Financial Studies. 2000.

[9]. Kumar, S.S.S. Comparative Performance of Volatility Forecasting Models in Indian Markets. Decision. 2006; 33(2).

[10]. McMillan, D., Speight, A. and Apgwilym, O. Forecasting UK Stock Market Volatility. Applied Financial Economics. 2000; 10(4): 435-448.

[11]. Nilsson, C. Forecasting Swedish stock market volatility and value-at-risk: A comparison of EWMA and GARCH models. Master Essay II — NEKP01. School of Economics and Management Department of Economics. Lund University. 2017.

[12]. Tse, Y.K. Stock Returns Volatility in the Tokyo Stock Exchange. Japan and the World Economy. 1991; 3(3): 285-298.
[13]. Walsh, D.M. and Tsou, G.Y.G. Forecasting Index Volatility: Sampling Interval and Non-trading Effects. Applied Financial Economics. 1998; 8(5): 477-485.
[14]. Yu, J. Forecasting Volatility in the New Zealand Stock Market. Applied Financial Economics. 2002; 12(3): 193-202.
[15]. Zhang, Z. and Pan, H. Forecasting Financial Volatility: Evidence from Chinese Stock Market. Working Paper In Economics And Finance No. 06/02. School of Economics, Finance and Business University of Durham. 2006.

Dr. Sonal Sharma. "Volatility Prediction through Ewma – A Review of Literature." *IOSR Journal of Economics and Finance (IOSR-JEF),* 12(2), 2021, pp. 28-32.