Quarterly Journal of Quantitative Economics(JQE) **(2023) 19(4) 43-78**

Shahid Chamran University of Ahvaz

Quarterly Journal of Quantitative Economics

Journal Homepage: www.jqe.scu.ac.ir
Print ISSN: 2008-5850
Online ISSN: 2717-4271

Comparison of GARCH Family Models in Estimating Value at Risk and Conditional Value at Risk on the Tehran Stock Exchange

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ARTICLE HISTORY	JEL CLASSIFICATION	KEYWORDS
Received: 07 April 2020 ***Revision: 11 December 2021*** ***Acceptance: 12 December 2021***	***C63, G10, G02***	***Value at Risk, Conditional Value at Risk, GARCH Models, Tehran Stock Exchange Index***

FURTHER INFORMATION:
This article is taken from the Ms Thesis of Ms. Masoumeh Haghparast in the field of Economic Sciences under the guidance of Dr. Leila Torki at University of Isfahan.
Acknowledgments: The authors are grateful for the valuable comments and suggestions of the judges who have improved the quality of this article.
Conflict of Interest: The authors declare no conflict of interest.
Funding: The authors received no financial support for the research, authorship, and publication of this article.

Shahid Chamran University of Ahvaz
Quarterly Journal of Quantitative Economics
(former Economic Studies)

How to Cite:
Torki, Leila., Esmaeeli, Neda & Haghparast, Masoumeh. (2023). Comparison of GARCH Family Models in Estimating Value at Risk and Conditional Value at Risk on the Tehran Stock Exchange. Quarterly Journal *of Quantitative Economics (JQE)*, 19(4), 43-78.
10.22055/JQE.2021.33186.2240

EXTENDED ABSTRACT

INTRODUCTION

Several criteria have been introduced in recent decades to measure risk, and each of them investigates the uncertainty problem from different perspectives. In 1996, thanks to the advancement of the mathematical sciences and statistics in evaluating undesirable risks, the criterion of Value at Risk (VaR) was introduced to measure risk, and it was welcomed by investors and financial analysts.

Therefore, the purpose of this study is to compare the average values of Value at Risk and Conditional Value at Risk(CvaR) estimated by five GARCH patterns for the Tehran Stock Exchange(TSE) index, in which the property of Arch is seen. Since the existence of the fat tail in the probability distribution of financial data has been confirmed, the T-Student distribution has been studied in addition to the normal distribution.

The results suggest that T-Student distribution has a more favorable performance for estimating Value at Risk and Conditional Value at Risk. Furthermore, there is no significant difference among the averages of Value at Risk and Conditional Value at Risk which are estimated by different GARCH patterns.

METHODOLOGY

This study seeks to investigate the difference among the average values of Value at Risk and Conditional Value at Risk for the index of Tehran Stock Exchange estimated by five GARCH patterns. Since the attractiveness of parametric statistics such as ease of generalizability and the existence of powerful quantification tools, parametric approaches contain a variety of models in the field of risk. Hence, in this study, VaR and CVaR with a

parametric approach have been calculated using different generalised autoregressive conditional heteroskedasticity patterns. In addition, after comparing the patterns with each other, the best pattern has been introduced. The applied research method in terms of purpose and data collection belongs to the applied and documentary studies, respectively and statistical population is the time series of daily data on the TSE index during the period 09/01/2013 to 09/01/2016 and includes 1445 observations.

The method of collecting data is a research library based on the daily reports of the TSE index, which is available on the Financial Information Processing of IRAN site (Fipiran.com). Analytical tools are econometric and statistical techniques and the generalised models of autoregressive conditional heteroskedasticity have been implemented. Moreover, the used softwares are Excel, R, Eviews 11.

For the ADF unit root test, a regression equation taking into the account the width in origin and the linear time trend is used. (Pesaran, 2005). The ADF regression order can be selected using the model selection criterion, such as the Akaik (AIC) or Schwartz (SIC). The Kopik test can be applied to the calculation of model accuracy to determine the value at risk. This test uses a very simple method to measure the error of the VaR calculation for past data. Since the Kopic test focuses only on the number of violations and ignores the existence of time dependencies. Christofferson (1998) developed the Kopik test and proposed a test for the level of conditional coverage by considering a separate statistic for the violation of independence test.

FINDINGS

The results of the reliability test for the variables indicate that at all levels of reliability, the data are not rooted and are reliable. Therefore, the ambiguity related to creating false regression due to data instability is removed.

The Lagrangian coefficient test for the TSE index proves the presence of the arch effect on the remainder of the autocorrelation equation for MA (1,1). Therefore, it is quite obvious that the work does not have the property of white noise despite the remaining arch, and generalized autoregressive conditional heteroskedasticity patterns should be used, which removes the arch effect from the data.

The results of estimating GARCH (1,1) show that the mean equation for the selected index in all cases is ARMA (1,1). Furthermore, the sum of the estimated coefficients in GARCH (1,1) for both distributions is close to one, indicating the existence of stability in the variance process. As a result of estimating the EGARCH model (1,1), It has been observed that the gamma

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parameter for both normal and T-student distributions are 0.4 and 0.3, respectively, which displays the presence of a positive leverage effect. By estimating the GARCH-M (1,1), we get GARCH-M (1,1) coefficients for both normal and T-student distributions, which are 0.5 and 0.2, respectively. This coefficient is the same as the risk margin, which indicates that the return is positively dependent on the volatility. The presence of this risk margin and its significance means the existence of a consistent correlation in past asset returns. The results of estimating two models APARCH (1,1), J GJRGARCH (1,1), which are other types of GARCH models used to model leverage effects, show that in GJRGARCH model the gamma coefficients for both normal and T-student distributions are -0.1 and -0.07, respectively. These coefficients indicate the presence of a negative leverage effect. Moreover, In the APARCH model the gamma coefficients for both normal and T-student distributions are -0.2 and -0.1, respectively, which proves the attendance of a negative leverage effect.

All in all, by applying the different Garch models for VaR and CVaR, the highest values for the TSE index Tehran at two confidence levels of 95% and 99% belong to the GARCH-M model (1,1) with the T-student distribution. The obtained values are 0.4850% and 0.8619%, respectively. In addition, for the normal distribution at the 95% confidence level, the GARCH-M, EGARCH, GJRGARCH, APARCH and GARCH models show the highest risk values, respectively. However, for the T-student distribution, GARCH-M, APARCH, EGARCH, GJRGARCH, and GARCH models present the highest risk values, respectively.

Furthermore, for the normal distribution at the 99% confidence level, GARCH-M, EGARCH, APARCH, GJRGARCH, and GARCH models show the highest risk values, respectively, and for the T-student distribution, GARCH-M, APARCH, EGARCH, GJRGARCH and GARCH models have the highest risk value, respectively. At two levels of 95% and 99% confidence, the highest value of conditional risk is related to the GARCH-M model (1,1) with T-student distribution and with rates 0.6492% and 2863%, respectively. Considering the normal distribution at both 95% and 99% confidence level, GARCH-M, EGARCH, APARCH, GJRGARCH and GARCH models show the highest CVaR, respectively. However, assuming T-student distribution for both levels of 95% and 99% confidence results that the GARCH-M, APARCH, EGARCH, GJRGARCH and GARCH patterns have the highest conditional risk value, respectively.

The accuracy and adequacy of different models were evaluated by back testing methods. The results indicate that for the calculated VaR at 95%

confidence level, the null hypothesis is rejected for the normal distribution. This means that none of the patterns with normal distribution have sufficient validity to calculate VaR. On the other hand, the null hypothesis for all models with the T-Student distribution is not rejected at the 95% level of confidency. and all the models with the T-Student distribution are valid to calculate VaR. At the 99% confidence level for both normal and T-student distributions, the results show that based on the corresponding ps of Kopic and Christofferson tests, all patterns have the necessary validity and adequacy to calculate VaR, and the null hypothesis is not rejected.

CONCLUSION

The results propose the T-Student distribution as a favorable probability distribution for estimating Value at Risk and Conditional Value at Risk through the five introduced GARCH models. Moreover, there is no significant difference among the averages of Value at Risk and Conditional Value at Risk which are estimated by different GARCH patterns. The findings of this research aim to help better investment in the stock market. Therefore, investors and agents can also benefit from the applied methods in this research to calculate the daily risk value for different industries in TSE.

For future research, it is recommended to use very recent GARCH models such as 3D-GARCH, COGARCH, GARCH-MIDDAS, etc. Furthermore, according to the significant effect of probability distribution selection, it is suggested to check other probability distributions. In the present paper, the adequacy and accuracy of different models have been evaluated. However, due to the possibility of VaR overestimation by a model which results in the loss of resource allocation in a bank or company, ... , it is suggested to rank different methods for value at risk by using different loss function methods.

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