MEASURING THE MARKET RISK OF VN-INDEX PORTFOLIO BY VALUE AT RISK MODEL

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The paper presents an econometric approach based on time series models AR, MA and ARMA combined with ARCH, GARCH and developed GARCH models to forecast and quantify market risk via VaR measure for market portfolio (VN-Index, thereby offering some technical conclusions about characteristics of the VN-Index and suggestions for investors about a flexible and proactive risk management based on VaR measure for their portfolios

Keywords: VaR identifying model, VN-Index ROR, Basel criteria, price fluctuation band, market risk

1. Problem

Financial collapses in the early 1990s and recent years among major financial organizations in many countries all over the world originate from the unusual upheavals in market conditions. Billions of dollar have been lost and many valuable lessons drawn. This situation has made market risk the biggest worry for planners, investors and law-makers as well.

Developed since 1993, Value at Risk measure, abbreviated as VaR, was considered as a breakthrough and effective tool for measuring and managing market risk. Amended Basel Agreement 1996 considered VaR the basis for a legal infrastructure, and a uniform and level playing field for international financial organizations. The application of VaR in financial organizations is continuously developed, which can be generalized through three main levels: measurement criteria; a tool for comparing the market risk degrees among different positions; and an instrument for managing risk in a proactive and flexible manner.

In stock investment, VaR is used for not only identifying and forecasting the possible maximum loss, helping establish the necessary capital at risk in a risky stock market, but also as a basis for controlling the market risks, evaluating the results of investment adjusted to risk and scientific grounds for allocating more capital to or withdrawing it from a certain portfolio.

As for Vietnamese stock market, market risk has not been paid much attention. Almost investment decisions are mainly based on qualitative analyses. Models for the forecast and quantification of market risk are rarely used or at a limited extent.

In this article, we forecast and quantify the market risk by VaR measure on market portfolio (VN-Index) using parameter approach through time series econometrics models: AR, MA and ARMA together with ARCH, GARCH, TGARCH, EGARCH and IGARCH.

2. Value at Risk model

a. VaR measure:

VAR is defined as a measure of the potential maximum loss in market value of financial instruments as well as the whole portfolio of future financial instruments for a given probability level over a defined period.

In terms of mathematics, VaR measure is defined:

$$P\left[V_t - V_0 < V\text{aR}\right] = 1-\alpha \quad (1)$$

where,

VaR means Value at Risk;

V_0: Present or original value of a portfolio;

V_t : Future value of a portfolio after a given and period, defined as:

$V_t = V_0 e^{r_t}$

α: probability of the market value of an asset or portfolio, not exceeding VaR.

From (1), VaR measure can be written under form of return on assets ratio as follows:

$$P\left[r_t(\tau) < r_t^*(\tau)\right] = \int_{-\infty}^{r^*} f(r)\,dr = 1-\alpha \quad (2)$$

where $r_t^*(\tau)$ is the lowest rate of return (ROR) on stocks after a period τ with corresponding probability of 1-α; $r(\tau)$ is the continuous ROR on stocks in period τ, defined as: $r(\tau)=ln(P_{t+\tau}/P_t)$, P_t: market value of stock at the time t, and f(r) is probability distribution density function of ROR. Accordingly, VaR is defined:

$$V\text{aR} = V_t^* - V_0 = V_0\left[e^{r_t^*(\tau)} - 1\right] \quad (3)$$

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Thus, VaR measure depends on two main factors:

- Assessment period is the fixed time period to forecast the potential changes in the market value of a portfolio. The selection of assessment period is based on the estimated balance between cost and benefit. According to the Basel Committee, selected assessment period is 10 (ten) business days [2] whereas according to RiskMetrics, assessement period should be 01 (one) business day for portfolio of short-term investments and 25 business days for ones of long-term investments.

- Given loss probability is decided by the risk manager. In terms of capital safety, loss probability should be selected so as to minimize cases in which real loss value exceeds Var-based forecasts. The Basel Committee suggests that the loss probability should not exceed the given VaR of 99%, whereas RiskMectrics suggests 95% for both trading and investment transactions.

b. Model for identifying VaR in stock investment:

In order to identify the VAR for stock, we use econometric approach by autoregressive integrated moving average (ARIMA) model with variance of the error described by Heteroskedasticity models with autoregressive condition. General formula of the models is as follows:

* Model ARMA(p,q) – GARCH(r,m):

$$r_t = c + \sum_{j=1}^{p} \phi_j r_{t-j} + \varepsilon_t + \sum_{i=1}^{q} \theta_i \varepsilon_{t-i}, \varepsilon_t = \sqrt{h_t} u_t, u_t \sim iid\, GED(0,1). \quad (4)$$

$$h_t = \kappa + \sum_{j=1}^{r} \delta_j h_{t-j} + \sum_{i=1}^{m} \alpha_i \varepsilon_{t-i}^2,$$

With conditions: $\kappa > 0$, $\delta_j \geq 0$ $\alpha_i \geq 0$, $\sum_{j=1}^{p}(\delta_j + \alpha_j) < 1, p = \max(r,m)$, and module of roots of equations $1-\sum_{j=1}^{p} z^j \phi_j = 0$, $1-\sum_{j=1}^{p} z^j (\delta_j + \alpha_j) = 0$ outside the unit circle; r_t is continuous ROR on stocks, h_t is conditional variance of ROR of stocks. In case $\delta_j=0$ with $\forall j = \overline{1r}$ the model will become ARMA (p, q) – ARCH (m).

* Model ARMA(p,q) – EGARCH(r,m,s) [6, 7, 13]:

$$r_t = c + \sum_{j=1}^{p} \phi_j r_{t-j} + \varepsilon_t + \sum_{i=1}^{q} \theta_i \varepsilon_{t-i}, \quad \varepsilon_t = \sqrt{h_t} u_t, \quad u_t \sim iid\, GED(0,1). \quad (5)$$

$$\ln(h_t) = w + \sum_{j=1}^{r} \beta_j \ln(h_{t-j}) + \sum_{i=1}^{m} \alpha_i \left[\left| \frac{\varepsilon_{t-i}}{\sqrt{h_{t-i}}} \right| \right] + \sum_{k=1}^{s} \delta_k \frac{\varepsilon_{t-k}}{\sqrt{h_{t-k}}}.$$

With s: asymmetric level of the model.

* Model: ARMA – TGARCH:

$$r_t = c + \sum_{j=1}^{p} \phi_j r_{t-j} + \varepsilon_t + \sum_{i=1}^{q} \theta_i \varepsilon_{t-i}, \quad \varepsilon_t = \sqrt{h_t} u_t, \quad u_t \sim iid\, GED(0,1). \quad (6)$$

$$h_t = w + \sum_{j=1}^{r} \beta_j h_{t-j} + \sum_{i=1}^{m} \alpha_i \varepsilon_{t-i}^2 + \sum_{k=1}^{s} \delta_k \varepsilon_{t-k}^2 I_{t-k},$$

where $I_{t-k}=1$ if $\varepsilon_{t-k}<0$ and $I_{t-k}=0$ when $\varepsilon_{t-k}>0$; and s is the asymmetric level of the model.

In model (6), positive information ($\varepsilon_{t-k}>0$) and negative data ($\varepsilon_{t-k}<0$) will have different impacts on the conditional variance of ROR. The impact of positive information (positive shock) on the fluctuation is α_i, while the influence of negative information will be $\alpha_i + \delta_i$. If $\delta_i > 0$, negative information will increase the fluctuation in ROR, also known as leverage effect at the level i. Thus, if $\delta_i \neq 0$, the impact of price shocks on the fluctuation in ROR of stocks will be asymmetric.

* Model ARMA – IGARCH:

$$r_t = c + \sum_{j=1}^{p} \phi_j r_{t-j} + \varepsilon_t + \sum_{i=1}^{q} \theta_i \varepsilon_{t-i}, \quad \varepsilon_t = \sqrt{h_t} u_t, \quad u_t \sim iid\, GED(0,1). \quad (7)$$

$$h_t = w + \sum_{j=1}^{m} \delta_j h_{t-j} + \sum_{i=1}^{r} \alpha_i \varepsilon_{t-i}^2,$$

With restrictive conditions:

$$\sum_{j=1}^{r} \delta_j + \sum_{i=1}^{m} \alpha_i = 1. \quad (8)$$

A GARCH model satisfying (8) is called an integrated GARCH model of degree r, m; signed as IGARCH (r, m). With condition (8),

$$1 - \sum_{j=1}^{p} z^j (\delta_j + \alpha_j) = 0$$

may have unit root. Thus, IGRACH model enables the description of conditional variance of ROR series in case it appears unit roots in the squared residual series of the kinetics description model of the ROR series of stocks.

Above models are in general forms. Depending on the characteristic of each data series, they may become AR, MA models or ARMA combined with ARCH, GARCH, TGARCH, EGARCH or IGARCH. Probability distribution used here is a generalized error distribution, denoted GED (Generalized error distribution) [10]. This probability distribution form is highly flexible and overall which are commonly used in financial science to describe the probability distribution of stock ROR when appearing "leptokurtotic" property.

c. Testing fit of VaR identifying model:

A VaR identifying model is considered to be fit if it meets tests on the fitness of model [12]. Most of these tests are backtestings which mean using some observations not included in the model to test the fitness of the model. In this article, we use two methods of backtesting on the fitness of VaR identifying models: Testing based on criteria of the Basel Committee [11] and Statistical Testing of P.Kupiec (1995) [9] with 250 observations (equivalent one year of observation) used for the backtesting.

a. Data sources:

In order to carry out the process of assessing and testing VaR identifying models for VN-Index (VNI) series, we collect daily VNI samples (from July 28, 2000 to Oct. 30, 2009) comprising: 2,154 days observed, and 1,904 observed days of which, from July 28, 2000 to Oct. 31, 2008, are used to assess and test the parameters of the VaR identifying model. For the remaining 250 observations (from Nov. 3, 2008 to Oct. 30, 2009), they are used to test the fitness of the VaR model according to the test criteria of the Basel Committee and P. Kupiec (1995).

Table 1: Historical data of price fluctuation bands applied to HCMC Stock Exchange:

Effective from	Fluctuation band	Causes
July 28, 2000	(+/-) 5%	To keep fluctuation bands at a narrow level thereby avoiding shocks for the market.
Aug. 1, 2000	(+/-) 2%	There were worries about an increasing number of investors and buying power exceeding the volume for sale.
June 13, 2001	(+/-) 7%	The market wants to prove that it has enough conditions and ability to smoothly operate and investors take responsibility for their own decisions. Fluctuation bands are widened to ensure autonomy.
Oct. 10, 2001	(+/-) 2%	The first adjustment after nearly four months of decreases in buying power and price on the whole market, right after the peak of VNI 571 points in June 2001.
Aug. 11, 2002	(+/-) 3%	The adjustment aims at reviving the activeness of the market after months of low trading volumes, and the supply of stocks rapidly increases as more companies are listed.
Jan. 2, 2003	(+/-) 5%	To enhance the attractiveness of the market, and increase its liquidity when demand is lower than supply.
March 27, 2008	(+/-) 1%	To stabilize the psychology of the investing community and limit selling out stocks and paying off mortgages in order to stabilize the market when it goes down so fast and deeply (Official Letter 467/UBCK-PTTT dated March 25, 2008).
April 7, 2008	(+/-) 2%	After considering developments of the market and mentality of investors and carrying out solutions instructed by the Prime Minister in Official Letter 1909/VPCP-KTTK, State Securities Commission of Vietnam (SSC) issues the Official Letter 529/UBCK-PTTT allowing HOSE to temporarily adjust the fluctuation bands of price of stocks and fund certificates.
June 19, 2008	(+/-) 3%	In order to enhance the attractiveness of the market after entering a more stable period. (Official Letter 1160/UBCK-PTTT dated June 16, 2008).
From Aug. 18, 2008 up to now	(+/-) 5%	In order to enhance the attractiveness and liquidity of the market, and avoid abnormal changes when macroeconomic conditions have experienced positive developments: better signs in interest rate, exchange rate, trade gap and inflation could be seen.

Source: State Securities Commission of Vietnam

3. Assessing and testing the VaR identifying model for VN-Index series

b. Results of assessing and testing the daily VaR identifying model for VN-Index:

According the parameter approach, in order to assess the VaR identifying model, it is necessary to assume the probability distribution form of ROR series. Jarque – Bera (JB) test rejects the assumption that probability distribution of VN-Index series complies with normal distribution. However, statistical data Kurtosis = 5,265 and skewness = -0,191 show that probability distribution form of VN-Index ROR is nearly symmetric distribution and is leptokurtotic. Therefore, GED will be used to assess the model.

The model form is identified through ACF and PACF for VN-Index ROR series and square of VN-Index ROR series. After many assessments, the form results of models are identified: ARMA(4.5) – GARCH(2.3), ARMA(4.5) – EGARCH(2.3), ARMA(4.5) – TGARCH(2.3), ARMA(4.5) - IGARCH(1.1) and ARMA(4.5) - IGARCH(2.2). And the ARMA (4.5) - IGARCH (2.2) model has the highest confidence level. Assessing model results are as follows :

$$r_t = 0,242r_{t-1} + 0,775r_{t-4} + \varepsilon_t + 0,120\varepsilon_{t-1} - 0,740\varepsilon_{t-4} - 0,243\varepsilon_{t-5}$$

$$\varepsilon_t = h_t^{1/2}u_t, \quad u_t \sim i.i.d\ GED(0,1,v), \quad v = 1,318$$

$$h_t = 1,512h_{t-1} - 0,530h_{t-2} + 0,352\varepsilon_{t-1}^2 - 0,340\varepsilon_{t-2}^2$$

According to the assessing result, ARMA model (4.5) – IGARCH (2.2) is highly reliable. Tests on white noise, significance level of parameters, ARCH test on standardized residual series by R.F. Engle (1982) and the fitness of the model shows

Table 2: Assessment results

Content	ARMA(4,5) – IGARCH(2,2)
Percentile of standardized GED corresponding with parameter “v” with the probability of 1%	-2.582
R^2	0.141499
Adjusted R^2	0.137866
Akaike info criterion	-6.197861
Log likelihood	5893.869
Test- Stat of ARCH by R.F. Engle (1982) (N-p)R^2	9.9234
Critical value of chi-squared distribution p = 5 degrees of freedom corresponding to probability of mistake of type I: 1%	15.0863
Conclusions about the heteroskedasticity over time.	Accepting the hypothesis H_0: there is no heteroskedasticity over time in the standardized residual of the model on the basis of observed samples.
Conclusion: The model is appropriate with the theory.	57.44246
Critical value of the chi-squared distribution with 36 degrees of freedom corresponding probability of mistake of type I: 1%	58.61921
Conclusion on the standardized residue of the model.	Standardized residue of the model is a white noise series. The model is consistent with theory.
The probability that actual losses not exceeding the forecast VaR or the coefficient of reliability in VaR identifying model.	1%
Number of exception cases in the 250 observations.	0
Frequency of exception cases in the sample of 250 observations.	0%
Kupiec statistical value.	unidentified
Conclusions on the fitness of the model:	

+ According to Basel criteria	There is no exception in this model, which is consequently placed into the green zone. The probability of mistake of type I when rejecting the model is 91.9%. The model is suitable and is accepted according to Basel criteria.
Mean square error of daily forecast VaR of VN-Index (RMSE) in 250 observations.	14.58 points

that it completely satisfies theoretical conditions and highest criteria of Basel Committee (there is not any exception during one forecast year).

RMSE coefficient of the model reaches 14.58 points, the lowest in models estimated by employing observed samples. Therefore, this model satisfies not only the demand for forecast of market risk and capital adequacy but also the request to minimize the risk contingency reserve. Thus, this is a model of high reliability among models estimating forecast of input parameters, which is used to identify and forecast VaR measure for VN-Index based on empirical data from nine years of daily observation.

Assessing process of these models indicates: root inversion of AR process with square residue series in models ARMA-GARCH, ARMA-TGARCH, ARMA-EGARCH makes unit roots appear. Therefore, the model appropriate to the task of forecasting the conditional variance structure of VN-Index ROR in this case is IGARCH. In our opinion, some reasons for this situation are as follows:

(i) Theoretical studies on IGARCH model shows that as for data series described by IGARCH, there are external factors persistently influencing and changing the fluctuation structure of data series [13]. As for conditional variance of VN-Index ROR, the most significant factor is price fluctuation band. Price fluctuation band is the technical limit which strongly effects on ROR of stocks on the Vietnamese stock market; and on the global level, is considered as a tool for adjusting the market behavior and causing changes in variance structure of VN-Index ROR.

(ii) Crowd psychology and mutual possession of stocks among companies that causes a pervasive effect are also factors affecting fluctuation in VN-Index ROR. However, the influence of the VN-Index on variance of ROR is lower than that of price fluctuation band on the market.

In order to test and assess the influence of price fluctuation band on fluctuation in VN-Index ROR, we adjust ARMA (4.5) – IGARCH (2.2) model. After various assessments, more appropriate model is AR (5) – IGARCH-M (2.2) with the exogenous variable "price fluctuation band – PFB" added to structure of conditional variance of VN-Index ROR, and the conditional variance integrated into expecting equation of VN-Index ROR. The assessing results are as follows:

$$r_t = 0,0063 + 0,3625 r_{t-1} - 0,0498^* r_{t-2} + 0,0774 r_{t-4} + 0,0687 r_{t-5} + 0,0006 ln\left(h_t\right) + \varepsilon_t$$

$$\varepsilon_t = h_t^{1/2} u_t, \quad u_t \sim i.i.d\; GED\left(0,1,v\right), \quad v = 1,455$$

$$h_t = 0,3095\varepsilon_{t-1}^2 + 0,3049\varepsilon_{t-2}^2 - 0,3032 h_{t-1} + 0,6887 h_{t-2} + 7,03.10^{-5} BDDD$$

Assessment results show that AR (5) – IGARCH-M (2.2) model is appropriate to the theory. The appropriateness of the model is improved in comparison with ARMA (4.5) – IGARCH (2.2) model. ARCH test on standardized residue of the model shows that there is no heteroskedasticity. Parameters assessed in this model have a very high significant level; only AR (2) with p-value equaling 2.97% while p-value of other coefficients equaling approximately 0%. This model satisfies the highest requirement of the Basel Committee. There is not any exception during the entire year of forecasting VaR on VN-Index. It is estimated that GED has v = 1,455 with its peak much higher than standard distribution that allows a description of leptokurtotic characteristic of empirical distribution of VN-Index ROR. RMSE coefficient of the model gets 14.13 points, lower than result produced by ARMA (4.5) – IGARCH (2.2) model. Therefore, AR (5) – IGARCH-M (2.2) model with GED and v =1.455 is selected as the VaR identifying model for VN-Index.

VN-Index forecast result: The possible lowest VN-Index with confidence level of 99% in 250 backtesting observations is described in the following figures:

Table 3: Assessment results

Content	AR(5) – IGARCH-M(2,2)
Percentile of standardized GED corresponding with parameter "v" with the probability of 1%	-2.517
R^2	0.154558
Adjusted R^2	0.150078
Akaike info criterion	-6.173667
Log likelihood	5869.810
Log likelihood	5.869,810
Test- Stat of ARCH by R.F. Engle (1982) $(N\text{-}p)R^2$	10.7665
Critical value of chi-squared distribution p = 5 degrees of freedom corresponding to probability of mistake of type I: 1%	15.0863
Conclusions about the heteroskedasticity over time.	Accepting the hypothesis H_0: there is no heteroskedasticity over time in the standardized residual of the model on the basis of observed samples.
The probability that actual losses not exceeding the forecast VaR or the coefficient of reliability in VaR identifying model.	1%
Number of exception cases in the 250 observations.	0
Frequency of exception cases in the sample of 250 observations.	0%
Kupiec statistical value.	Unidentified
Conclusions on the fitness of the model:	
+ According to Basel criteria	There is no exception in this model, which is consequently placed into the green zone. The probability of mistake of type I when rejecting the model is 91.9%. The model is suitable and is accepted according to Basel criteria
Mean square error of daily forecast VaR of VN-Index (RMSE) in 250 observations.	14.13 points

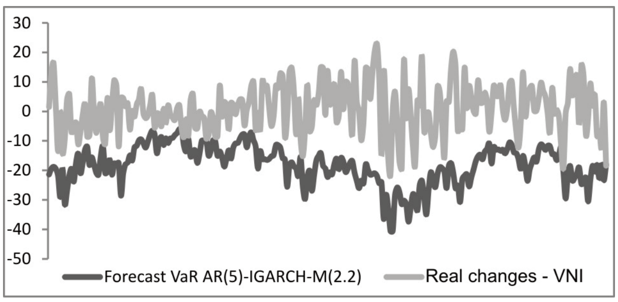

Figure 1: Comparison between forecast VaR and real changes in VN-Index

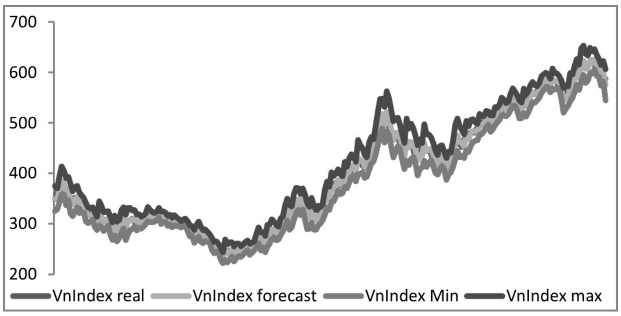

Figure 2: Comparison between VN-Index real, VN-Index forecast and VN-Index-max, VN-Index-min corresponding with probability P[VNI min < X=x < VNI Max] = 0.98

4. Conclusion from the results of empirical assessment

a. Direct conclusions from the results of empirical assessment:

Firstly, AR(5) – IGARCH-M (2.2) model with GED and parameter v of 1.455 affirms that, in Vietnamese stock market, the price fluctuation band (PFB) significantly affects on structure of forecast variance of VN-Index ROR, which have firm scientific grounds based on 1,899 observations. Assessment results show the sensitivity of PFB to conditional variance of VN-Index ROR is 7.03×10^{-5} with a statistical significance p-value of 0%. In our opinions, this is the main factor that constantly influences the fluctuation structure of data series. Consequently, there appear unit roots in the root aversion of AR process on squared residue series in estimated models. Therefore, GARCH model is theoretically appropriate to the task of describing the kinetics of conditional variance of VNI ROR. It is possible to infer a conclusion from the assessment results that in new stock markets which are strongly regulated by the government through technical instruments, the ROR variance structure of stocks is more likely to be changed by exogenous factors. In order to set up models describing serial dependence of conditional variance of stocks in this case, IGARCH models with exogenous variables should be preferentially selected.

Secondly, test results show that VN-Index ROR does not follow normal distribution but it has a "leptokurtotic" characteristic. Therefore, when setting up the forecast models for VN-Index or determining the forecast variance in risk measure models, the distribution to be selected is T-student or GED. According to the assessing and testing results based on 1,904 observations, from July 28, 2000 to Oct. 31, 2008, we find that GED is more suitable and provides more reliable results than the T-student distribution. It is because the GED is highly flexible enough to describe distribution forms with leptokurtotic characteristic.

Thirdly, the VAR identifying model for VNI has confirmed the efficient-market hypothesis (EMH) and GARCH effect on ROR series on Vietnamese stock market with the VN-Index as the representative sample. Accordingly, Vietnamese stock market shows the weak EMH as well as the existence of GARCH effect. Both facts imply the role of past publicly available information in market price forecasting. The structure of model AR(5) - IGARCH-M(2.2) shows the serial dependence of forecast value of VN-Index on historical observations, accordingly:

(i) Forecast VN-Index ROR is dominated by changes in VN-Index ROR in 1, 2, 4 and 5 days earlier. And VN-Index ROR in 1, 4 and 5 days earlier has a positive correlation with forecast VN-Index ROR with the sensitivity of the information reflected in the value of ROR forecasts decreasing over time. Information of one day before has higher sensitivity than 4 to 5 days earlier, which show itself in sign and magnitude of the estimation coefficients of rt-1, rt-4 and rt-5 in the AR model: ϕ_1, ϕ_4 và $\phi_5 > 0$; $\phi_5 = 0,0687 < \phi_4 = 0,0774 < \phi_1 = 0,3625$. This result is the basis for forecasting the changes in market index. Accordingly, the changes in market index can be measured through the changes in the closing prices in 1, 4 and 5 days earlier.

The results of forecasting the VN-Index in the model show that the root mean square error (RMSE) of model corresponding to 2,149 observations is 8.985 points and corresponding to 250 backtesting observations is 8.099 points. The result of this forecast is the lowest in models estimated.

(ii) Conditional variance of VN-Index ROR depends on the squared ROR, the fluctuation range of VN-Index ROR in 1 and 2 days earlier. Furthermore, the structure of variance equation also indicates that price fluctuation band has a significant influence on fluctuation range of VN-Index ROR.

(iii) The structure of expectation equation allows investors to identify the risk premium through component 6.10-4ln(ht). This is the basis for identifying the risk premium of the market ROR. The result is important to analysis of investment decisions by investors in the Vietnamese stock market, indicating the market's expectation about the risk premium when investing in the market portfolio.

Therefore, based on the magnitude and sign of the estimated coefficients, VN-Index ROR, shocks at different times and the risk premium in the model structure, investors can analyze the influence extent, risk premium expectation to forecast ROR as well as VN-Index of the next day. However, it is worth noting that, according to theoretical researches as well as empirical tests, the confidence level of the forecast results will be lower if the data is not regularly updated. Therefore, in order to ensure a high confidence level of forecast results, individuals and organizations have to regularly update data. According to the RiskMetrics as well as the Basel Committee, the data used for estimating the VaR must be updated on a daily [12] or at least monthly [2] basis.

b. Practical meanings for investors:

Approaching by moving average autoregressive model with heteroskedasticity with autoregressive condition provides a scientific method as a basis for investment decisions:

Firstly, it helps identify and forecast the potential maximum loss when investing in any stock in the market, and serves as a scientific basis showing whether risks investors have to face are within limits allowed by sources of capital or not; thus setting the market risk capital requirements in investing process.

Secondly, investors can consider the approach by econometrics model ARMA-GARCH and developed GARCH in order to identify VaR measure for stocks in time-series portfolio, which provides a foundation for capital allocation or withdrawal from stocks by analyzing the following indicators:

(i) The marginal risk value (VaR_m^i) of a portfolio is a measure that allows investors to determine the degree of changing VAR of the portfolio when the value of a component asset (stock) of the portfolio changes one unit.

(ii) The increased risk value (δVaR) allows the identification of the degree of change in VaR of a portfolio when all component stocks of the portfolio change at the same time.

(iii) Component risk value $CVaR_i$ is a VaR measure of each stock in a portfolio. $CVaR_i$ divides VaR of the entire portfolio into different components. $CVaR_i$ shows how the VAR of a portfolio change when a stock i is removed from the portfolio.

(iv) $MRAPM_i$ is a measure used for comparing correlation between increased VaR when adding a unit in value of assets (stock) i in the list and expected profit to be achieved. This indicator shows how much profit is generated by an extra unit of VaR added to the stock i. This tool helps measure the result of risk adjusted investment, and serves as a basis for investors to decide whether to invest or withdraw capital from the business sector. $MRAPM_i$ is defined as:

$MRAPM_i$ = Expected profit from the stock (i) / VaR_m^i

$CRAPM_i$ determines how the allocation of funds to or withdrawal of all investment in stock i will make the VaR of the entire portfolio change. CRAPMi is an important basis for investors to consider allocating funds to or withdrawing it from a business or a certain stock in the portfolio.

$CRAPM_i$ = Net profit from shares (i) / $CVaR_i$

Thirdly, approaching the problem by ARMA-IGARCH-M model allows investors to predict market price as well as market expectation about the risk premium when investing in different stocks. This is an important basis for investors to analyze and select portfolio as well as the time of investment.

Fourthly, with the econometric approach using the autoregressive moving average model with the heteroskedasticity with autoregressive conditions, investors can identify and forecast two parameters at the same time: expectation and conditional variance of the stocks over time. These are the two most important input parameters to establishment of the optimal portfolio according to Markowizt's mean-variance analysis■

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