International Journal of Economics, Commerce and Management
United Kingdom ISSN 2348 0386 Vol. VIII, Issue 12, Dec 2020

http://ijecm.co.uk/

VALUE AT RISK (VaR) & TAILED VALUE AT RISK (TVaR): COMPANIES LISTED IN LQ45

Maria Yus Trinity Irsan
School of Business, President University, Indonesia
maria.irsan@president.ac.id

Muara Lysta Sirait
School of Business, President University, Indonesia

Abstract

Value at Risk (VaR) and Tailed Value at Risk (TVaR) are two tools for obtaining market risk. Both tools provide a value that represents the maximum possible risk in the future with a certain confidence level. VaR and TVaR will produce one value of with a confidence level of α and a time horizon of T. X value can be used to predict changes in stock prices within a certain period of time. This research shows how VaR (using Monte Carlo Algorithm) and TVaR are simulated. The data used are the stock prices of companies listed in LQ45, monthly time horizons, and three levels of confidence: 70%, 80%, 90%. VaR and TVaR results are compared with the actual company return. This comparison shows that some TVaR provides more appropriate results than VaR

Keywords: VaR, TVaR, Monte Carlo Simulation, Risk, Return

INTRODUCTION

Capital market is a place for a variety of long-term financial instruments that can be traded, i.e., bonds, equities (stocks), mutual funds, derivative instruments, etc. The capital market is a means of funding for companies and other institutions (like the government), and as a means for investing activities. Thus, the capital market provides various facilities and infrastructure for buying and selling activities and other related activities.

Licensed under Creative Common

Stock is one of the most popular financial market instruments that many investors choose, due to stocks are able to provide an attractive rate of return. even though investment gives a possible profit, the investment instruments also carry the risk of either a capital loss or a loss of potential profits. Financial Risk is the potential loss that may be faced in an investment, which can cause the loss of all or a part of the invested capital. In stock transactions, losses occur because the investor sells the shares at a lower price than the purchase price.

The increase or decrease in stock prices is influenced by internal and external factors of the company. The company's internal factors include management, reputation, finance, company management, and products, while external factors include politics, regional and international economic conditions, technology, laws and regulations, people's purchasing power and competition. The expectation of the investors for their investment is to obtain maximum returns with a certain level of risk. Therefore, investors must know how to measure the risks that can be borne in each investment made.

Value at Risk (VaR) is a method that is often be used to calculate the maximum value of Financial Risk that investors may face in a period of time under normal conditions. (Hull, 2015) defined VaR as single number that summarizes the total risk in portfolio. VaR can be calculated from either the probability distribution of gains or the probability distribution of losses. VaR is a popular method to determine total risk, yet VaR has weakness. VaR is a popular method for determining total market risk, yet has weaknesses, which are, VaR only measuring the percentile of the distribution of profits or losses without considering any losses that exceed the VaR level and are incoherent (because it does not have sub-additive properties).

Tailed Value at Risk (TVaR) is a similar method with VaR, that provide a single number to describe the maximum possible market risk. TVaR considers the loss beyond the VaR level and also proved to be sub-additive, that assure TVaR is coherence as a risk measure (Yamai & Yoshiba, 2002). It is calculated based on VaR result, while VaR can be obtained by historical method, variance-covariance methods and Monte Carlo simulation. Determining VaR using historical and variance-covariance approach has been introduced in (Irsan & Simbolon, 2019).

In this paper, TVaR and VaR are calculated based on Monte Carlo Simulation. The result will be compared with the actual difference of stock price of 36 companies listed in LQ45. The paremater used are monthly time horizon and three confidence level, 70%, 80%, and 90%.

LITERATURE REVIEW

VaR at a given probability level α, is defined to be the predicted amount of financial loss of a portfolio over a given time horizon (Degiannakis, Floros, & Livada, 2012). VaR is an attempt to quantify the maximal probable value of capital that may be lost over a specified period of time

Licensed under Creative Common

(Wirch, 1999). VaR is incoherent risk measure due to failed to be sub-additive, sub-additive means for two risks combined will not be greater that for the risks treated seperately. There are five properties of coherent risk: (Artzner, Delbean, Eber, & Heath, 1997)

- The risk measures must be limited above by the maximum possible net loss.
- The risk measure must be sub-additive
- The risk measure must be scalar multiplicative.
- The risk measure must be independent of the size of possible gains.
- The risk measure must be scalar additive.

In (Klugman, Panjer, & Willmot, 2012) define the following properties for a coherent risk measures. Let $\rho(X)$ is the notation of risk measures, for any two loss random variables X and Y:

1. Sub-additive: $\rho(X+Y) \leq \rho(X) + \rho(Y)$
2. Monotonicity: if $X \leq Y$ for all possible outcomes, then $\rho(X) \leq \rho(Y)$
3. Positive homogeneity: for any positive constant c, $\rho(cX) = c\rho(X)$
4. Translation invariance: for any positive constant c, $\rho(X+c) = \rho(X) + c$

The following definitions are the formal definition of VaR and TVaR.

Definition 1. (Klugman, Panjer, & Willmot, 2012) Let X denote a loss random variable. The Value-at-Risk (VaR) of X at $100\alpha\%$ confidence level, is the 100α percentile (or quantile) of the distribution of X.

Definition 2. (Klugman, Panjer, & Willmot, 2012) Let X denote a loss random variable. The Tailed-Value-at-Risk (VaR) of X at $100\alpha\%$ confidence level, is the expected loss given that the loss exceeds the 100α percentile (quantile) of the distribution of X.

By the definition above, the calculation of TVaR is based on the result of VaR, in other words, TVaR is a function of VaR. (Klugman, Panjer, & Willmot, 2012) write the relation between TVaR and VaR as follows: $TVaR(X) = VaR(X) + e(\pi)$

where $e(\pi)$ is the average loss function evaluated at the 100αth percentile.

In determining VaR, there are three most important elements, those are the amount of potential loss, a specific time within the risk is estimated and the probability of loss or reliability (Bogdan, Baresa, & Ivanovic, 2015). (Bogdan, Baresa, & Ivanovic, 2015) explained three basic method to calculate VaR:

- Historical method. This method is a popular method among financial and non-financial entities, due to it is easy to modify. This method uses historical market prices and make a decision based on the historical scenario.
- Variance-Covariance method. This method also known as the parametric method. Two primary variables that parametric method use in its calculation, are namely the mean

Licensed under Creative Common

value of the yield rate, and the standard deviation of the same data. The basic requirement of parametric methods is that the yields of securities are normally distributed, and that the distribution corresponds to a theoretical distribution such as Gauss's.

- Monte Carlo Method. This method that uses in this paper. The Monte Carlo method is stochastics methods that requires computer simulation of various influences on the observed portfolio of securities. The complete flow to calculate VaR using this simulation is describe on Figure 1.

All methods mention above calculate the return of the stock price as the very first step. The return price can be calculated as follows:

$$R = \frac{P_n - P_{n-1}}{P_{n-1}}$$

where, P_i is the price at time t and R is the return.

METHODOLOGY

This research compares the result between VaR and TVaR in determining market risk. VaR and TVaR were simulated using Python, based on Monte Carlo Simulation. The following flowchart shows how VaR is calculated using Monte Carlo Simulation.

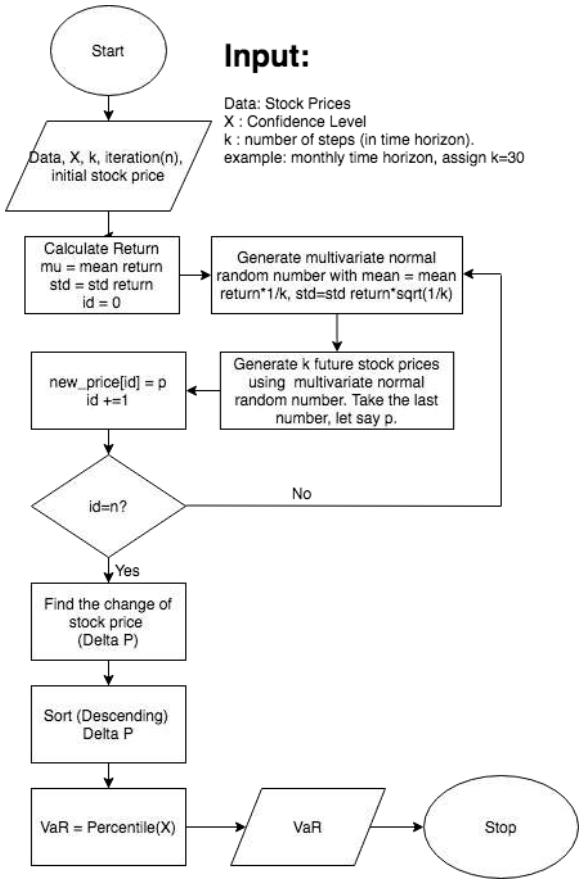

Figure 1. Flowchart of Monte Carlo Simulation

Licensed under Creative Common

After VaR value obtained, TVaR simulated as follows: (Klugman, Panjer, & Willmot, 2012). Suppose that $FP_1 < FP_2 < \cdots < FP_n$ is an ordered possible risk from Monte Carlo Simulation, if α is confidence level used, let $k = [\alpha n] + 1$, then

$$TVaR(X) = \frac{1}{n-k+1}\sum_{i=k}^{n} FP_i.$$

This results (VaR and TVaR) then compares with the actual risk, i.e, $P_{n-1} - P_n$, where P_i is the stock price at given time i.

RESULTS

Data used in this research is the closing stock prices of companies listed in LQ45 for the period January 2009 to December 2019 (source data: finance.yahoo.com). The parameters used are monthly time horizon and three confidence levels (70%, 80%, 90%). Due to some companies did not provide complete data (some companies go public after January 2009), then all incomplete data was deleted. The remaining data consist of 36 companies. The following figure shows the stock prices of 36 companies for the period January 2009 to December 2019.

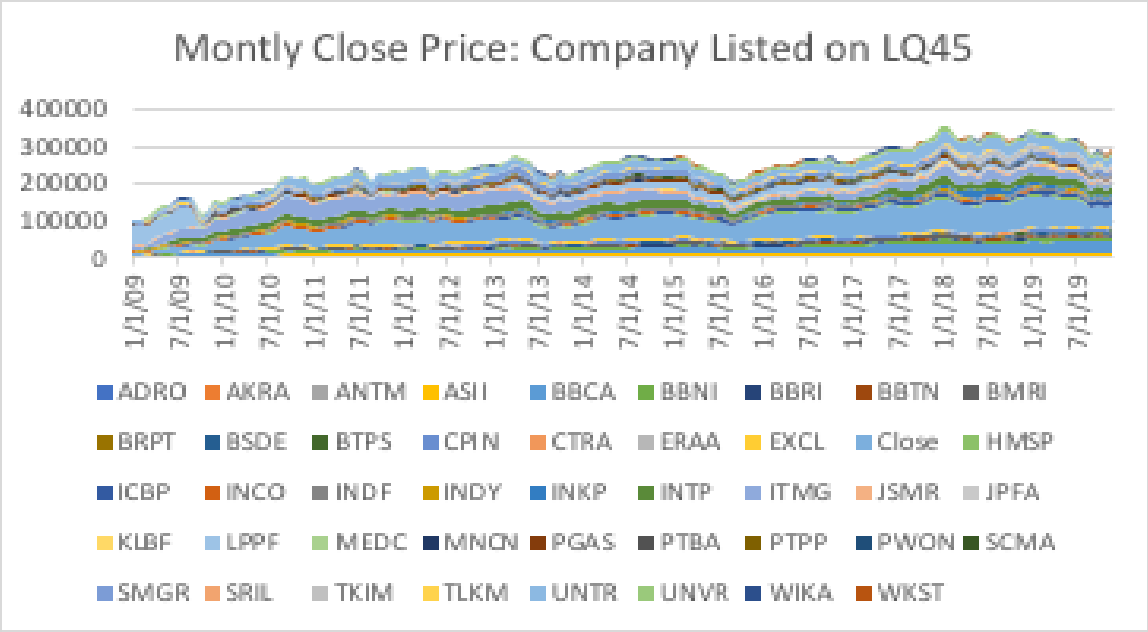

Figure 2. Close Stock Prices of 36 companies

The following figures are the VaR and TVaR simulation result for three confidence levels, 70%, 80% and, 90%.

Licensed under Creative Common

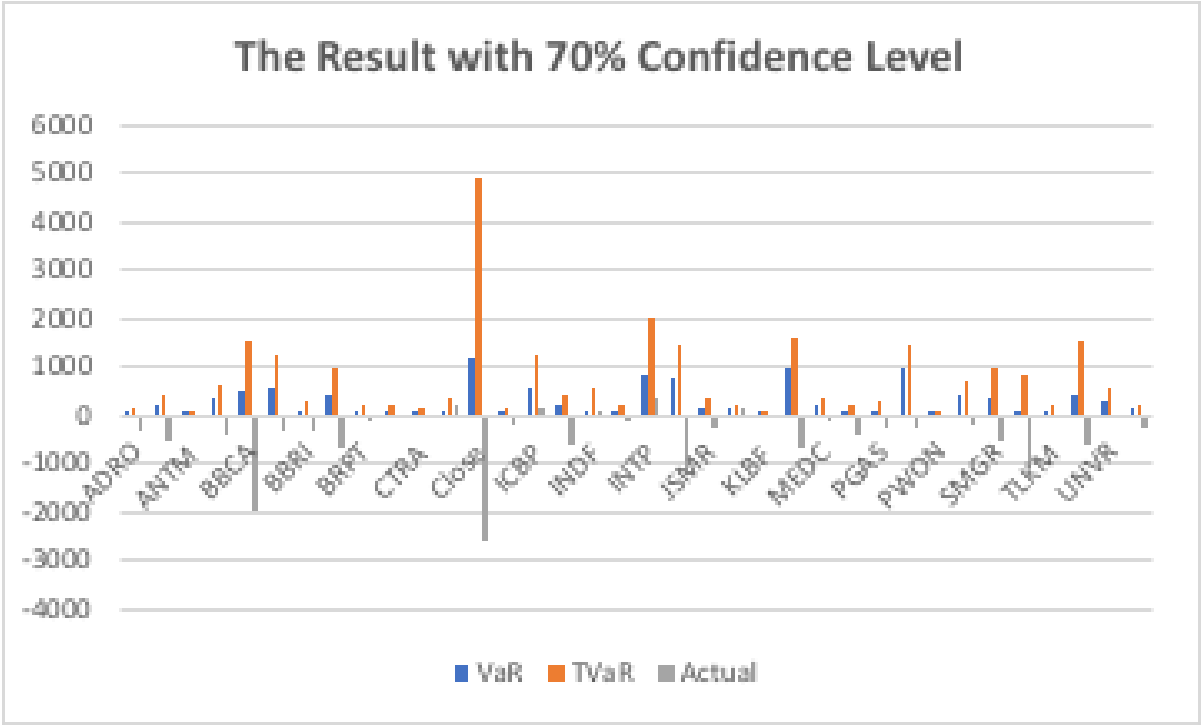

Figure 3. VaR, TVaR and Actual Difference with $\alpha = 70\%$

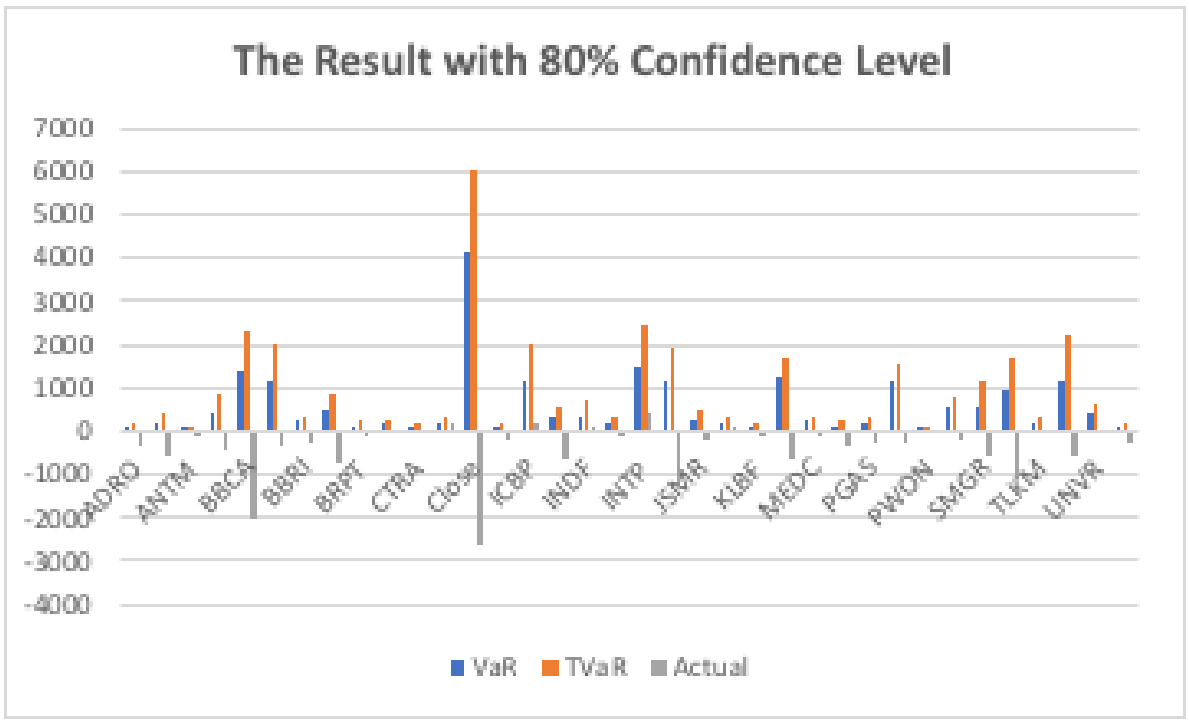

Figure 4. VaR, TVaR and Actual Difference with $\alpha = 80\%$

Licensed under Creative Common

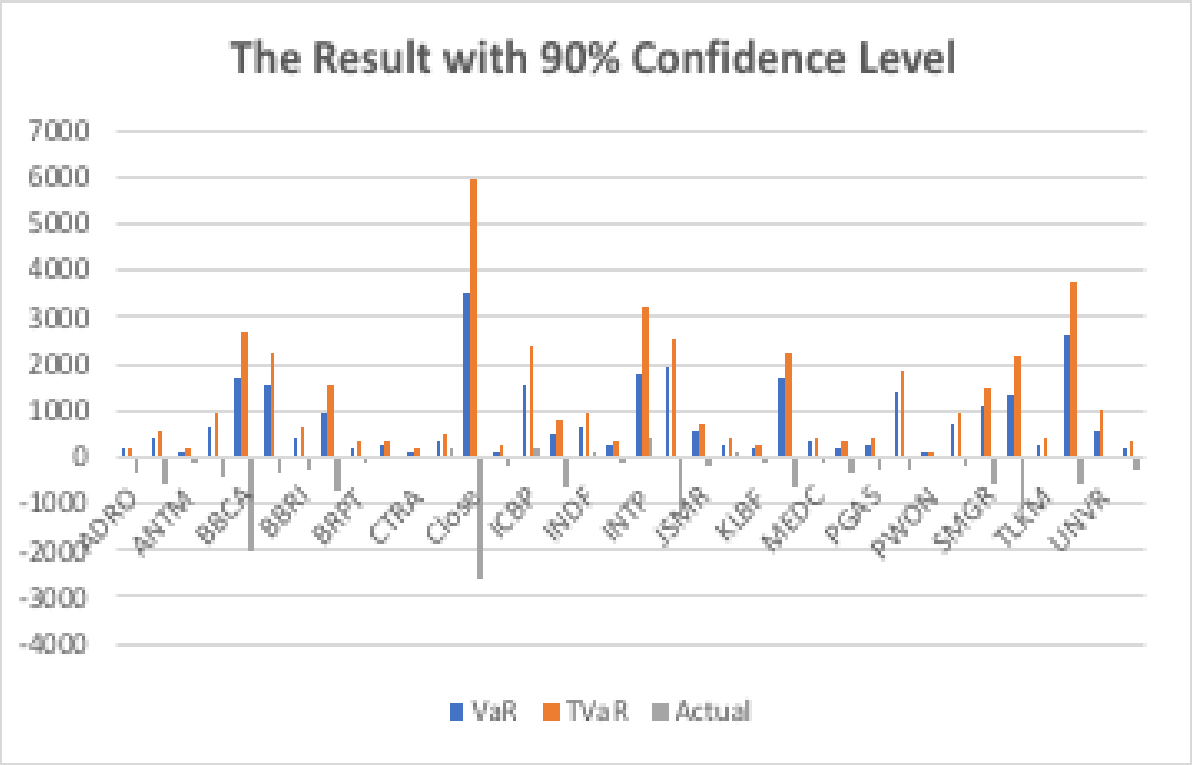

Figure 5. VaR, TVaR and Actual Difference with $\alpha = 90\%$

From the results above, there are 5 companies that experienced a decline in prices at the end of the period. The companies and its actual decline price, VaR, and TVaR are shown in the following table:

Table 1. Result Comparison VaR and TVaR with $\alpha = 80\%$

No	Companies	Actual $\Delta P = P_{n-1} - P_n$ (Rp)	VaR (Rp)	TVaR (Rp)
1	EXCL	190	83.78	336.16
2	ICBP	175	555.36	1241.61
3	INDF	25	82.27	530.05
4	INTP	375	861.53	1987.15
5	JPFA	130	112.04	246.65

Licensed under Creative Common

Table 2. Result Comparison VaR and TVaR with $\alpha = 80\%$

No	Companies	Actual $\Delta P = P_{n-1} - P_n$ (Rp)	VaR (Rp)	TVaR (Rp)
1	EXCL	190	187.44	354.83
2	ICBP	175	1174.50	2039.05
3	INDF	25	361.92	699.01
4	INTP	375	1450.27	2470.36
5	JPFA	130	153.82	304.60

Table 3. Result Comparison VaR and TVaR with $\alpha = 90\%$

No	Companies	Actual $\Delta P = P_{n-1} - P_n$ (Rp)	VaR (Rp)	TVaR (Rp)
1	EXCL	190	334.64	483.82
2	ICBP	175	1538.64	2388.33
3	INDF	25	618.49	913.11
4	INTP	375	1809.96	3209.36
5	JPFA	130	260.60	434.68

Table 1 shows that from 5 companies which experienced decline in stock price at the end of the period, there were two companies whose VaR failed to cover their risk, while TVaR could cover all possible risk for all companies. From Table 2, VaR failed to cover risk for 1 company and TVaR still cover all possible risk. Table 3 shows that both VaR and TVaR can cover all risks. Basically, from the methodology on the previous section, it is clear that TVaR is always greater than VaR. This condition makes TVaR more likely to cover possible risks than VaR.

CONCLUSION

VaR and TVaR can be used to measure the risk of the stock price. Based on simulation using three confidence levels, 90%, 80%, and 70%, TVaR provides more appropriate results than VaR. These results shown as follows:

- For 90% of confidence level, the actual difference (between stock price in Nov.19 and in Des.19) is all less than VaR and TVaR.
- For 80% of confidence level, the actual difference (between stock price in Nov.19 and in Des.19) is all less than TVaR, and there was one company has actual difference bigger than VaR.

Licensed under Creative Common

- For 70% of confidence level, the actual difference (between stock price in Nov.19 and in Des.19) is all less than TVaR, and there were 2 companies has actual difference bigger than VaR.

In this paper VaR and TVaR are calculated and compared based on data on closing prices of companies listed in LQ45 which provides that only 5 companies experienced a decline in stock price at the end of the period. For further research, other companies as well as time horizon will be considered. In addition, comparisons using one confidence level can also be reviewed.

ACKNOWLEDGEMENT

We gratefully thank to RISTEKDIKTI for the research grant which highly support us in conducting this research. Our appreciation also goes to President University for motovating us in conducting research.

REFERENCES

Klugman, S. A., Panjer, H. H., & Willmot, G. E. (2012). *Loss Models. From Data to Decisions. Fourth Edition.* United States of America: John Wiley & Sons, Inc.

Hull, J. C. (2015). *Risk Management and Financial Institution. Fourth Edition.* United States of America: John Wiley & Sons, Inc.

Yamai, Y., & Yoshiba, T. (2002). On the Validity of Value-at-Risk: Comparative Analyses with Expected Shortfall. *Monetary and Economics Studies*, 57-86.

Bogdan, S., Baresa, S., & Ivanovic, Z. (2015). Estimating Risk on The Capital Market with VaR Method. *UTMS Journal of Economics*, 165-175.

Degiannakis, S., Floros, C., & Livada, A. (2012). Evaluating value-at-Risk Models Before and After the Financial Crisis of 2008: International Evidence. *MPRA: Munich Personal RePEc Archive*.

Wirch, J. L. (1999). Raising Value at Risk. *North American Actuarial Journal*, 106-115.

Artzner, P., Delbean, F., Eber, J., & Heath, D. (1997). Thinking Cohorently. *RISK*, 68-71.

Irsan, M. Y., & Simbolon, I. P. (2019). Value at Risk: Companies Listed on LQ45. *The Third International Conference of Family of Business and Entrepreneurship* (pp. 874-881). Cikarang: President University.

Licensed under Creative Common