# การประมาณมูลค่าที่มีความเสี่ยงและมูลค่าที่มีความเสี่ยงแบบมีเงื่อนไข : หลักฐานของตลาดหลักทรัพย์ สปป.ลาว

# Estimating Portfolio's Value-at-Risk and Conditional Value-at-Risk: Evidence of Laos Securities Exchange

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## บทคัดย่อ

บทความนี้ ผู้วิจัยใช้ราคาปิดรายวันจากตลาดหลักทรัพย์ สปป.ลาว ระหว่างวันที่ 11 ตุลาคม 2562 ถึงวันที่ 27 พฤษภาคม 2564 (ไม่รวมวันหยุดนักขัตฤกษ์) จำนวน 402 วัน และประมาณค่าผู้วิจัยความเสี่ยงของพอร์ตการลงทุนโดยใช้ มูลค่าของความเสี่ยง (VaR) คุณค่าทางเงื่อนไข -แบบจำลองที่มีความเสี่ยง (CVaR) วิธีการคำนวณมูลค่าความเสี่ยง ในแง่มุมของ Historical Simulation และวิธีการแบบเกาส์เซียน (Gaussian methods) โดยมีช่วงความเชื่อมั่น 95%, 97.5% และ 99% ตามลำดับ

ผลจากวิธีการจำลองในอดีตพบว่า VaR ของบริษัท Phousy Construction and Development Public Company (PCD) มีมูลค่าสูงสุด และ Lao Cement Public Company (LCC) มีค่าต่ำสุด สำหรับฟังก์ชัน CVaR พบว่า PCD ยังคงเป็นบริษัทที่มีมูลค่าสูงสุด และบริษัท มหาทุนลิสซิ่ง จำกัด (มหาชน) (MHTL) มีมูลค่าต่ำสุด (ความเชื่อมั่น 95%) สำหรับวิธีการแจกแจงแบบเกาส์เซียน พบว่า VaR ของ PCD ยังคงเป็นบริษัทที่มีความเสี่ยงสูงสุด และ MHTL มีค่าต่ำสุด และในด้านของ CVaR พบว่า PCD และ MHTL ยังคงเป็นบริษัทที่มีมูลค่าสูงสุดและต่ำสุด นักวิจัยสรุปว่า CVaR ดีกว่า VaR เพราะ CVaR ทำให้เราสูญเสียที่คาดหวังโดยเฉลี่ย ในขณะที่ VaR ให้ช่วงของการสูญเสียที่อาจเกิดขึ้นแก่เรา หรือมีความแม่นยำน้อยกว่าในการประมาณความเสี่ยงที่ต่ำกว่า เมื่อเปรียบเทียบพอร์ตหุ้นที่ซื้อขายใน LSX จำนวน 11 หุ้น พบว่า VaR และ CVaR ของพอร์ตการลงทุนในรูปแบบ การกระจายแบบเกาส์เซียน (Gaussian Distribution) ต่ำกว่าวิธี Historical Simulation และการกระจายแบบเกาส์เซียนที่ระบุเป็นตัวบ่งชี้ความเสี่ยงที่ดีกว่า เนื่องจากมีค่าใกล้เคียงมูลค่าจริงมากกว่า

**คำสำคัญ:** มูลค่าที่มีความเสี่ยง มูลค่าที่มีความเสี่ยงแบบมีเงื่อนไข การกระจายแบบเกาส์เซียน

## ABSTRACT

This paper, researcher used daily closed price from Lao Securities Exchange during October 11, 2019 to May 27, 2021 (exclude public holidays), equal to 402 days and estimating of portfolio's risk researcher by Value-at-Risk (VaR) and Conditional Value-at-Risk (CVaR) models in the aspects of Historical Simulation and Gaussian methods with the confidence interval of 95%, 97.5% and 99% respectively.

Result in historical simulation method expressed that VaR of Phousy Construction and Development Public Company (PCD) has highest value and Lao Cement Public Company (LCC) has lowest value. For CVaR function found that PCD remain the company that has highest value and Mahathuen Leasing Public Company (MHTL) has lowest value (95% confidence). For Gaussian Distribution method found that VaR of PCD remain the company that has highest risk and MHTL has lowest and in aspects of CVaR found that PCD and MHTL remains the companies that has highest and lowest value and researcher concluded that CVaR is better than VaR because CVaR gives us an average expected loss while VaR gives us a range of potential losses or it less accurate lower approximation of risk. For comparison of the portfolio of 11 traded stocks in LSX indicated that portfolio's VaR and CVaR in Gaussian Distribution method is lower than Historical Simulation method and specified Gaussian Distribution analysis is a better risk indicator because it is closer to the actual value



**Keywords:** Value-at-Risk, Conditional Value-at-Risk, Gaussian Distribution

## 1. Introduction

Risk is an uncertain event that may have a positive or negative impact on the project or budget therefore risk management is the process of identifying and migrating risk. In mathematical perspective considered a procedure for shaping a loss distribution and an investor's risk profile. Risk management is an important aspect that investors and executives should be understand in order to manage the risk at an acceptable level. Generally, the methods used by financial institutions to measure risk are Value-at-Risk (VaR) and Conditional Value-at-Risk (CVaR). Nevertheless, it could not help to avoid the situation of financial crisis and its severe impact on economies globally. VaR represents a worst loss associated with a probability and a time horizon (an investment stability over time) while as CVaR is the expected loss or quantified the expected losses that occur beyond the VaR breakpoint.

Based on literature reviews indicated that the choice of VaR and CVaR in management of financial risk is popular which depend on the data, stability of statistical, optimization process and an acceptable for the related organizations. Lao PDR is an infantile country and land-locked country which Lao Securities Exchange (LSX) was just established in 2011 and there are only two companies (BCEL and EDL-GEN) and arrive in 2021 there are 11 companies likes Banque Pour Le Commerce Exterieur Lao Public (BCEL), Electricite Du Laos-Generation Public Company (EDL-GEN), Lao World Public Company (LWPC), Petroleum Trading Lao Public Company (PTL), Souvanny Home Center Public Company (SVN), Phousy Construction and Development Public Company (PCD), Lao Cement Public Company (LCC), Mahathuen Leasing Public Company (MHTL), Lao Agrotech Public Company (LAT), Vientiane Center Lao Public Company (VCL) and Lao ASEAN Leasing Public Company (LALCO). Currently, LSX plays an important role in driving economic growth, in 2019 with a total trading value of 78.89-billion-kip, volume of 19.33 million shares and the foreign investors covering 48.4% (Bank of Lao PDR, 2019). In the situation of country's economy slowdown effecting on some company's non-performance caused the demand for shares of listed companies sell their shares of lower price (compared with last year) especially EDL-Gen, PCD, BCEL, PTL and LCC as a result, the LSX index at the end of the first quarter of 2020 decreased (Laos Securities Exchange,2020). According to the daily trading data of LSX we see that the stock index has the least volatility, which in some months or quarters, the stock price of some companies is not fluctuating at all for example from April 8, 2021 to May 14, 2021 the stock price of LALCO was stable and from April 9,2021 to May 14,2021 the stock price of LCC was stable or not change.

There are many researchers used VaR and CVaR models to estimate the value at risk such as Yamai and Yoshiba (2005), Prapinmongkolkarn (2008) and Robert, Duc and Thach (2018) but there have never been used in the evidence of Lao PDR, especially in LSX therefore, this paper researcher used both VaR and CVaR to measure the risk of portfolio in LSX due to the choice between VaR and CVaR is not always clear. The researchers believe that the results

of this paper will provide new innovation or ideas to the related organizations, investors and readers as the basic information of decision making to invest in LSX.

### Objective of the Study

The main objective of this paper is estimating the portfolio of Lao Securities Exchange by Value-at-Risk and Conditional Value-at-Risk Models.

## 2. Literature Reviews

Allen, Powell and Singh (2012) measured market risk and credit risk before and during the financial crisis 2007-2009 by using parametric VaR and CVaR in terms of Monte Carlo Simulation Model, results indicated that CVaR will be able to measure the risk of high-risk industries during anomalies better. Bouraoui (2015) has measured the value-at-risk of the exchange rate between Baht and Dollar. Which used the daily data from the bank of Thailand between January 3, 2006 to December 30, 2014 by using Delta normal, historical simulation and historical simulation with exponentially weighting methods. The results indicated that each model has different levels of forecasting accuracy. Setting the confidence level in the VaR calculation also effect the accuracy of each model. The Delta Normal method is a model that allows the future data to be equal in estimating the parameters under the rate of return assumption is based on the normal distribution of the rate of return. Exchanging the abnormal distribution results in the calculated VaR being slightly inaccurate. It should be for a model using Historical Data Simulation as a model that uses an assumption to support a small distribution of returns, can predict the value. Historical Simulation with Exponentially Weighting is a model that gives more weight to the rounding information than in the past which able to accurately forecast the value of the risk as a backup.

Yamai and Yoshiba (2005) used Extreme Value Theory and copulas to comparison of VaR and CVaR measurement and expressed that CVaR can measure risk better than VaR. Prapinmongkolkarn (2008) used CVaR to create investment portfolio stocks in the SET50 index in 2006-2007 and compared its return on equity, the results indicated that CVaR provides a less volatile distribution of losses meaning that the chance of incurring a maximum loss are lower and the rate of return is higher compared to other methods. Furthermore, Robert, Duc and Thach (2018) found that nonparametric measures of VaR and CVaR may provide only limited new information to investors about relative risk in the portfolios examined as there is a high degree of similarity found in relative industry risk when using nonparametric metrics as compared to central or parametric measures such as standard deviation and parametric VaR

Webby, et al (2007) study the Mekong - Applications of Value at Risk (VaR) and Conditional Value at Risk (CVaR) simulation to the benefits, costs and consequences of water resources development in a large river basin and results found that when the loss distribution is continuous the CVaR is only marginally higher than the VaR. However, for the more realistic

model where the loss distribution is discontinuous, the CVaR is substantially greater and estimating the financial risk to which the national government and potential aid donors might be exposed given any damage to the fishery is the essence of this exploratory study of VaR and CVaR. In addition, Williams, Van Heerden and Conradie (2020) suggest that the filtered historical simulation VaR method is the best all round model and it is, however, worthwhile to employ Extreme Value Theory in the form of the conditional Generalized Pareto Distribution model when calculating extreme quantiles such as the 0.1% quantile.

## 3. Materials and Methods

This paper used the daily closed price of the companies registered in LSX such as BCEL, EDL-GEN, LWPC, PTL, SVN, PCD, LCC, MHTL, LAT, VCL and LALCO during October 11, 2019 to May 27, 2021 (exclude public holidays), equal to 402 days. For the estimating of portfolio's risk researcher used both VaR and CVaR models in the aspects of Historical Simulation and Gaussian methods by using the confidence interval of 95%, 97.5% and 99% respectively due to the sample was small.

### 3.1 Value-at-Risk (VaR)

Value-at-risk (VaR) is a measure of market risk that has been widely adopted since the mid-1990s for use on trading floors. It is A measure is an operationally defined procedure for assigning values. An attribute is that which is being measured. VaR has been commonly used as financial management tools to find the answer of how much we loss from the investment portfolio that occur with 1% and 5% probability in the future period which can be written as:

- **Historical Simulation Method**

$$VaR = \alpha\sigma w \quad (1)$$

$\alpha$: a probability such 95% of the confidence interval , $\alpha = 1.65$

$\sigma$: standard deviation of the investment portfolio

$w$: the portfolio value on the day of VaR is measured

- Parametric (Gaussian Distribution)

$$VaR = \mu + z\sigma \quad (2)$$

$\mu$: average of portfolio's return

$\sigma$: portfolio's volatility or standard deviation

$z$: z-score of the confidence interval

If researcher decrease the level of significance cause VaR increase, researcher only look at the left tail of the normal distribution since VaR is a one-tail test and it is concerned only with losses (Rajarshi, 2015).

### 3.2 Conditional Value-at-Risk (CVaR)

VaR model tell us how much at the minimum we could losses, without telling us the true extent of losses. In other words, VaR cannot estimate the actual size of the loss that may occur and it also doesn't tell us how likely are we going to see those loss days in a given time frame. Thus, Rockafellar and Uryasev (2000) introduced CVaR to measure the value at risk because it is likely to be a closer estimation of the actual loss once the loss exceeds VaR. CVaR derived from the weighted average of the "extreme" losses at the end of the distribution that exceed VaR. which written as:

$$CVaR = \frac{1}{1-C}\int_{-1}^{VaR} xp(x)dx \quad (3)$$

where, $p(x)dx$: the probability density of getting a return with value *"$x$"*

$C$: the cut-off points on the distribution where the analyst set the VaR breakpoint

VaR: Value-at-Risk

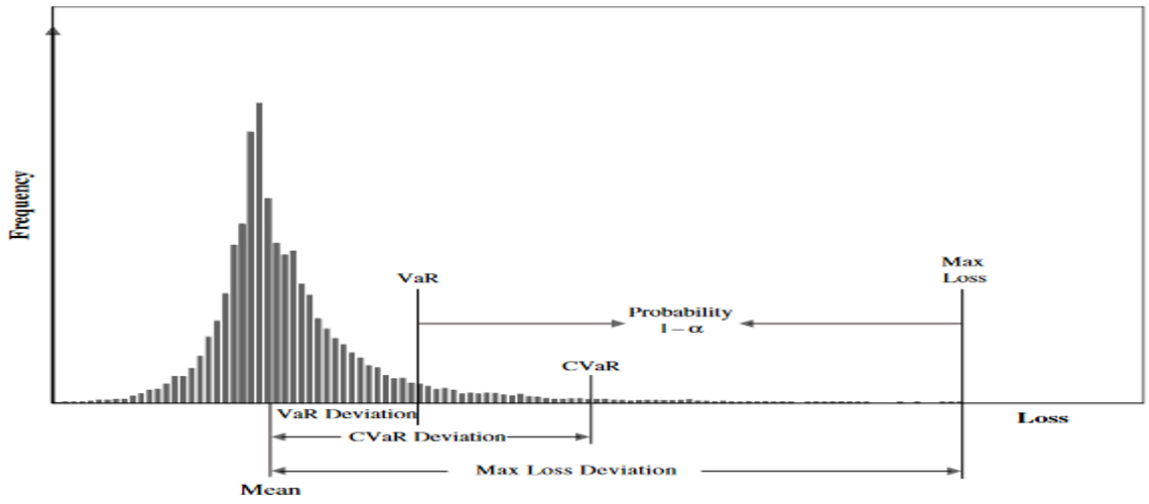


**Figure 1**. VaR, CVaR, deviations
Source: Sarykalin, et al (2008)

### 3.3 Portfolio Mean

A stock market portfolio is an investor's collection of stocks, funds, and other market-traded securities. In general, investment portfolios often include some cash and bond investments. A diversified portfolio holds a range of different assets, varied in size, industry, and other factors.

$$\mu = \begin{pmatrix} \mu_1 \\ \cdots \\ \mu_n \end{pmatrix}, w = \begin{pmatrix} w_1 \\ \cdots \\ w_n \end{pmatrix}, \Sigma = \begin{pmatrix} \sigma_{11}\ \sigma_{12}\ldots\sigma_{1n} \\ \sigma_{21}\ \sigma_{22}\ldots\sigma_{2n} \\ \cdots\ \cdots\ \cdots\ \cdots \\ \sigma_{n1}\sigma_{n2}\ldots\sigma_{n3} \end{pmatrix} \quad (4)$$

Portfolio return=$w^T \mu$

Portfolio Variance=$w^T \sum w$

$\mu_i$: means return of each stock or average vectors

$w_i$: weighted of portfolio or proportion of capital invested in difference stocks

$\sigma_i$:standard deviation of each stock

$\mu$: portfolio of LSX

$\sum$: variance-covariance

## 4. Empirical Results

### 4.1 VaR and CVaR of Securities

Based on the historical simulation and Gaussian distribution methods with a series of 402 observations and the confidence interval of 95%, 97.5% and 99% respectively, we get the value at risk and conditional value at risk of each stock or security as following:

**Table 1.** Comparison VaR and CVaR of each Stock

| Methods | Companies Registered in LSX | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | BCEL | EDL-GEN | LWPC | PTL | SVN | PCD | LCC | MHTL | LAT | VCL | LALCO |
| Probabilty | **5%** | | | | | | | | | | |
| **Historical VaR and CVaR** | | | | | | | | | | | |
| VaR(p) | -1.80% | -3.39% | -3.59% | -9.53% | -8.46% | -10.10% | -0.44% | -0.69% | -1.26% | -4.08% | -5.41% |
| CVaR(p) | -4.17% | -5.11% | -8.09% | -8.02% | -9.01% | -10.40% | -6.99% | -1.11% | -6.64% | -8.42% | -8.56% |
| **Parametric VaR and CVaR (Gaussian Distribution)** | | | | | | | | | | | |
| VaR | -2.46% | -3.38% | -4.50% | -6.67% | -5.66% | -7.70% | -3.66% | -0.78% | -3.96% | -4.57% | -4.75% |
| CVaR | 3.09% | 3.99% | 5.65% | 8.28% | 6.94% | 9.55% | 4.33% | 1.03% | 5.24% | 5.65% | 5.99% |
| Probabilty | **2.50%** | | | | | | | | | | |
| **Historical VaR and CVaR** | | | | | | | | | | | |
| VaR(p) | -3.67% | -4.88% | -9.12% | -9.96% | -10.16% | -10.47% | -8.96% | -1.05% | -7.41% | -9.72% | -9.31% |
| CVaR(p) | -6.31% | -6.34% | -9.84% | -10.38% | -10.41% | -10.54% | -10.09% | -1.53% | -9.30% | -10.34% | -8.86% |
| **Parametric VaR and CVaR (Gaussian Distribution)** | | | | | | | | | | | |
| VaR | -2.93% | -4.00% | -5.37% | -7.94% | -6.73% | -9.16% | -4.34% | -0.93% | -4.74% | -5.44% | -5.67% |
| CVaR | 3.51% | 4.54% | 6.40% | 9.39% | 7.87% | 10.83% | 4.92% | 1.16% | 5.92% | 6.41% | 6.79% |
| Probabilty | **1%** | | | | | | | | | | |
| **Historical VaR and CVaR** | | | | | | | | | | | |
| VaR(p) | -5.61% | -6.23% | -10.03% | -10.54% | -10.54% | -10.54% | -10.45% | -1.65% | -9.61% | -10.54% | -10.27% |
| CVaR(p) | -9.14% | -7.91% | -10.27% | 0.00% | 0.00% | 0.00% | -10.54% | -2.37% | -10.26% | 0.00% | -10.46% |
| **Parametric VaR and CVaR (Gaussian Distribution)** | | | | | | | | | | | |
| VaR | -3.480% | -4.732% | -6.368% | -9.417% | -7.970% | -10.869% | -5.129% | -1.110% | -5.649% | -6.446% | -6.727% |
| CVaR | 4.00% | 5.19% | 7.30% | 10.71% | 8.99% | 12.35% | 5.62% | 1.32% | 6.73% | 7.31% | 7.73% |

From table 1 above we found that at all confidence interval CVaR was higher than VaR both non-parametric and parametric methods because CVaR is defined as the average value of all losses that exceed the VaR, is interpreted Gaussian distribution adheres to conservation

investment strategy. In aspects of 95% confidence the value of VaR in historical simulation method which lower than Gaussian included BCEL, EDL-GEN, LWPC, LCC, MHTL, LAT and VCL, otherwise it is higher, meaning that Gaussian adheres to conservation investment strategy. But the value of CVaR in historical simulation method which lower than Gaussian included BCEL, EDL-GEN, LWPC, SVN and PCD.

For historical simulation method expressed that VaR of PCD has highest value, equal to 10.10% is interpreted as a 5% statistical chance of a loss of at least 10.10% over the following day. In contrast, the calculation indicated that VaR of LCC has lowest value, equal to 0.44% meaning that 95% confidence that maximum loss in a day would not exceed 0.44%, suppose if we invest in LCC with $1,000 and VaR(5%) of portfolio is just $4.4 in a day. At the same statistical level, researcher found that the CVaR of PCD remain the company that has highest value and equal to 10.4% meaning that in the worst 5% of returns investor average loss will be 10.4% and CVaR of MHTL has lowest value, equal to 1.11% meaning that in the worst 5% of returns investor average loss will be 1.11%.

For Gaussian Distribution method (Parametric) found that VaR of PCD remain the company that has highest risk, equal to 7.7% meaning that at 5% statistical chance of a loss of at least 7.7% or more on a given day an. At the same statistical level, MHTL has lowest VaR, equal to 0.78% meaning that at 5% statistical chance of a loss of investor in this company at least 0.78%. in aspects of CVaR, PCD and MHTL remains the companies that has highest and lowest value, equal to 9.55% and 1.03% respectively. In analytical, researcher try to decrease the level of significance and seen that both value of VaR and CVaR increase.

### 4.2 Risk Comparison of the Portfolio

This paper, comparison of the portfolio of 11 traded stocks in LSX based on assumption of VaR and CVaR. If we assume that we want to invest in LSX in the amount of $11,000 by dividing the investment proportion in each stock equally, we will get an investment weight of 9%, portfolio mean of -0.0224%, portfolio variance of 0.0084% and portfolio standard deviation of 0.919% which can calculate the portfolio's VaR and CVaR as follows:

**Table 2.** Portfolio's VaR and CVaR of 11 Traded Stocks in LSX

| Confidence Interval | Historical Simulation | | Parametric (Gaussian) | |
|---|---|---|---|---|
| | VaR | CVaR | VaR | CVaR |
| 95% | 1.63% | 2.24% | 1.53% | 1.87% |
| 97.5% | 1.91% | 2.75% | 1.82% | 2.13% |
| 99% | 2.69% | 3.97% | 2.16% | 2.43% |

For an aspect of historical simulation method found that 5% chance of loss at least 1.63% meaning that there is 5% chance that the minimum loss of portfolio would be $179.78 or more in a day which the 20$^{th}$ worst loss per day at least 1.64% and the 20$^{th}$ smallest return equal to 2.65% and in the 5% worst of return of portfolio's average loss will be 2.24%. For 2.5% chance, the minimum loss of portfolio would be $210.27 or more in day and 1% chance, the minimum loss of portfolio would be increased to $295.43 or more in a day. In terms of parametric method, at 5% chance of loss at least 1.53% meaning that the minimum loss of portfolio would be $168.83 or more in a day and worst of return of portfolio's average loss will be 1.87% in a given day.

The results from table 2 above expressed that portfolio's VaR and CVaR in Parametric (Gaussian Distribution) method is lower than Non-parametric (Historical Simulation) method. Therefore, it can be concluded that Gaussian Distribution analysis is a better risk indicator because it is closer to the actual value. Furthermore, Gaussian measurement also considers probability theory to calculate the maximum loss of an investment segment which illustrate the frequency as the figure bellows:

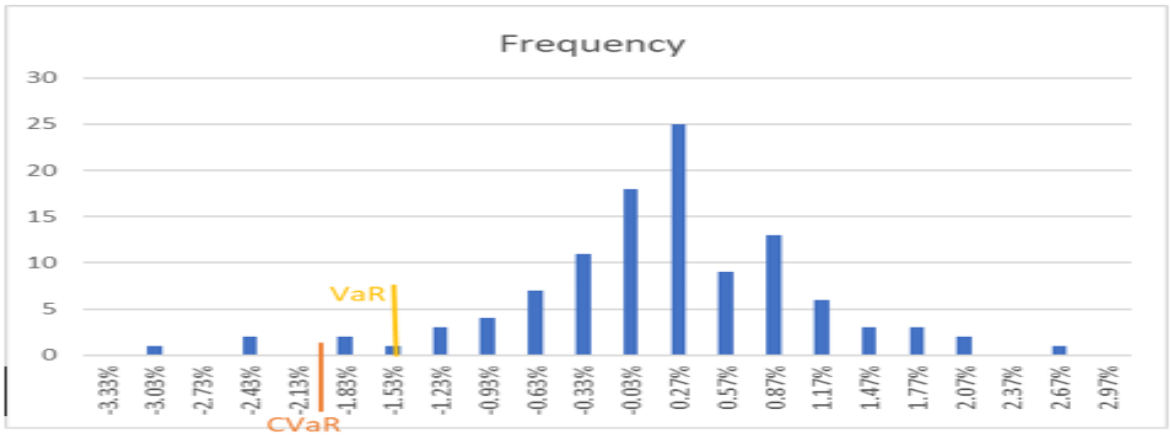


**Figure 2.** Frequency of Gaussian Distribution

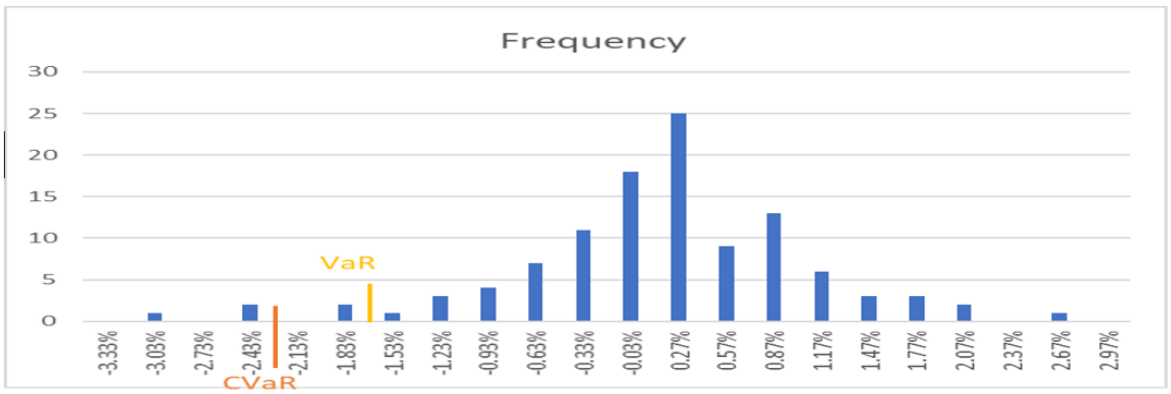


Figure 3. Frequency of Historical Simulation

## 5. Conclusion

### 5.1 Results Finding

According to the results, historical simulation method expressed that VaR of PCD has highest value and LCC has lowest value. For CVaR function found that PCD remain the company that has highest value and MHTL has lowest value (95% confidence). For Gaussian Distribution method found that VaR of PCD remain the company that has highest risk and MHTL has lowest and in aspects of CVaR found that PCD and MHTL remains the companies that has highest and lowest value and researcher concluded that CVaR is better than VaR because CVaR gives us an average expected loss while VaR gives us a range of potential losses or it less accurate lower approximation of risk.

For comparison of the portfolio of 11 traded stocks in LSX indicated that portfolio's VaR and CVaR in Gaussian Distribution method is lower than Historical Simulation method and specified Gaussian Distribution analysis is a better risk indicator because it is closer to the actual value.

### 5.2 Suggestions for Use in This Research

This study will provide some important information for investors who will decide to invest or buy the securities should buy low risk stocks such as BCEL and EDL-GEN because the price of these two stocks move every day, as well as paying divided every year. However, this paper is only a technical analysis so when deciding whether to invest or buying-selling, investors should consider more in fundamental factors.

### 5.3 Further Research

1. In estimating value at risk and conditional value at risk of portfolio and single stock of LSX researcher used only historical simulation and Gaussian Distribution methods to calculate therefore further researchers should consider Monte Carlo Simulation, Cornish-Fisher because difference approaches to calculating VaR and CVaR can lead to different results for the same portfolio.

2. If further researchers will go on with these results, they could imply them with monthly data because most of the stock in LSX market are inactive. There are some stocks that are almost 6 months the price so fluctuated.

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