Project 5 - Quantifying the Maximum Expected Loss

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1 Task 1

1.1 VaR

Value-at-Risk is a measure of risk of loss for a particular asset or portfolio over a given time period. VaR requires 3 components:

1. Timeframe
2. Confidence level
3. Loss amount

VaR answers the question: "What is the maximum amount(or percentage) that can be expected to be lost with probability of confidence level during the specified period of time.

There are 3 calculation methods:

1. Historical
2. Variance method
3. Monte Carlo method

1.2 Implementation

Quantify the Maximum Expected Loss for the next day using a Value-at-Risk (VaR) model. We are given:

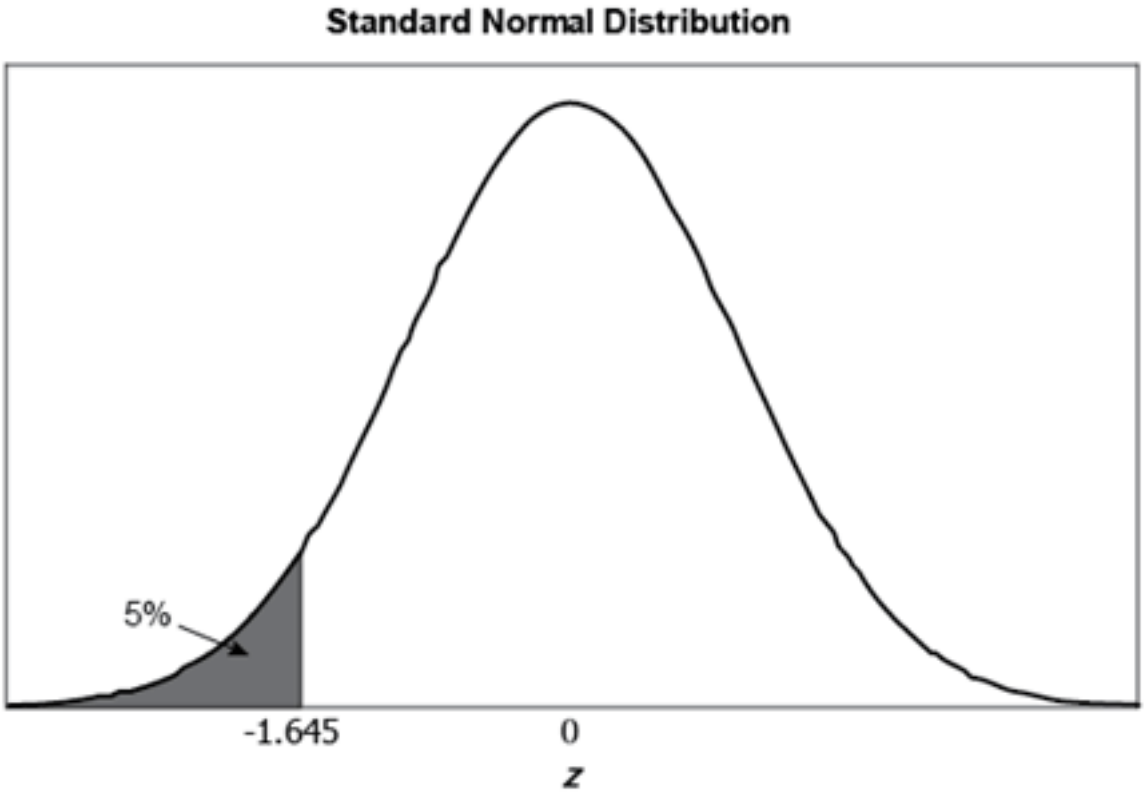
- Confidence level: 95%
- Volatility: 2.5%
- Current stock price: $126

We need to calculate the VaR. Our assumptions:

- The returns from the asset/portfolio is normally distributed.
- The returns are assumed to be serially independent so no prior return should influence the current return.

VaR can be calculated using next formula:

$$Var = Z\_score * Standard\_deviation * Investment\_Amount$$



The results are represented in the table below:

Calculate VaR:	
Confidence level:	95.00%
Volatility:	2.50%
Current stock price:	$126
Number of stocks:	100,000
Total Amount:	$12,600,000
Z score:	-1.64485
VaR:	$518,128.89

In Python I use the same formula which, obviously, gives us the same results.

2 Task 2

To calculate VaR with forecasted volatility the next algorithm is used:

1. Calculate daily returns
2. Implement GARCH(1,1) model
3. Forecast volatility using the model
4. Calculate VaR using the calculated volatility

2.1 GARCH model

- The GARCH model is an extension of the autoregressive conditional heteroscedasticity (ARCH) model developed by Engle in 1982. The acronym "GARCH" means "generalized autoregressive condition heteroscedasticity" model.
- The model helps to estimate volatility in financial markets.
- GARCH models are used by financial professionals in several areas including trading, investing, hedging and dealing.
- In general, if the process depends on the past p days' squared returns and the past q days' variances, the process is called a GARCH(p,q) process

- The model is implemented in python using **arch_model** function from **arch** package

The results are represented below:

```
VaR task 1: 518128.892490
Iteration:      1,   Func. Count:      6,   Neg. LLF: 379.973658183
Iteration:      2,   Func. Count:     19,   Neg. LLF: 379.031856167
Iteration:      3,   Func. Count:     28,   Neg. LLF: 378.913600221
Iteration:      4,   Func. Count:     35,   Neg. LLF: 378.236634018
Iteration:      5,   Func. Count:     42,   Neg. LLF: 378.048846648
Iteration:      6,   Func. Count:     49,   Neg. LLF: 377.644817579
Iteration:      7,   Func. Count:     55,   Neg. LLF: 377.258639413
Iteration:      8,   Func. Count:     61,   Neg. LLF: 377.165451711
Iteration:      9,   Func. Count:     68,   Neg. LLF: 377.15989473
Iteration:     10,   Func. Count:     74,   Neg. LLF: 377.157092984
Iteration:     11,   Func. Count:     80,   Neg. LLF: 377.1570368
Optimization terminated successfully.    (Exit mode 0)
            Current function value: 377.157036804
            Iterations: 11
            Function evaluations: 80
            Gradient evaluations: 11
VaR task 2: 427100.637891
```