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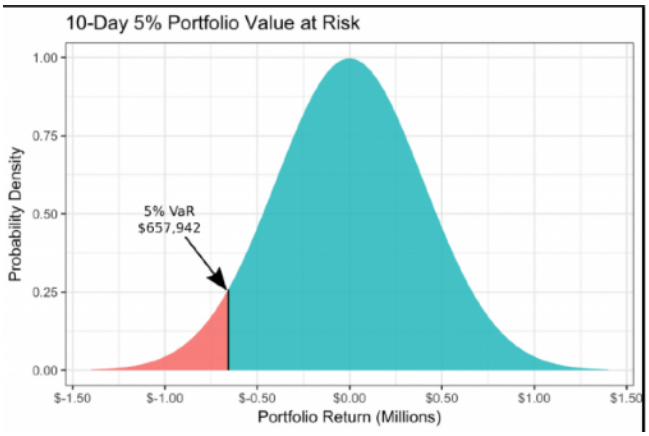
How to Minimise the VaR of of Portfolio

Value at Risk

Problem:



We want to calculate what would be the portfolio, which would give the lowest Value at Risk. Investopedia defines VaR as : “Value at risk (VaR) is a statistic that quantifies the extent of possible financial losses within a firm, portfolio, or position over a specific time frame.” The figure shows the VaR concept with a 5% probability, of the maximum loss.

Generally, the market uses 1% or 5% (or 99% or 95%, depending on how you calculate) probability to measure the “tail” of the normal curve.

There are three main methods to calculate the VaR:

1) Algebraic Model;
2) Historical Model;
3) Monte Carlo Model.

For the current study we will focus on the Historical Model with a twist. We do not intend to calculate the VaR for a given portfolio. Our objective is to find the optimal portfolio, which has the lowest VaR with a probability of 99%.

Data:

For this model we need historical data of the values for the assets (commodities and periods) as well as the limits to be invested in each assets/period (e.g. Nickel for 1, 3 or 6 month delivery), asset/total (e.g. Total for Nickel regardless of the period, for Tin, so on and so forth), total by type of asset (e.g., metals, agricultural, etc) and finally the total overall, with all types of assets added up no matter which commodity, period or commodity type.

HISTORICAL DATA EXAMPLE:

Date	Asset	1M	3M	6M	9M	1Y	2Y	3Y
01/01/2023	Nickel	0,123	0,124	0,125	0,345	0,234	0,123	0,234
02/01/2023	Nickel	0,123	0,124	0,125	0,345	0,234	0,123	0,234
01/01/2023	Tin	0,123	0,124	0,125	0,345	0,234	0,123	0,234
02/01/2023	Tin	0,123	0,124	0,125	0,345	0,234	0,123	0,234
…								
31/12/2024	Nickel	0,123	0,124	0,125	0,345	0,234	0,123	0,234
01/01/2025	Nickel	0,123	0,124	0,125	0,345	0,234	0,123	0,234
31/12/2024	Tin	0,123	0,124	0,125	0,345	0,234	0,123	0,234
01/01/2025	Tin	0,123	0,124	0,125	0,345	0,234	0,123	0,234

LIMITS (WILL BE THE CONSTRAINTS) FOR EACH COMBINATION ASSET/PERIOD EXAMPLE:

Asset	1M	3M	6M	9M	1Y	2Y	3Y
Nickel	2	3	2	1	3	4	0
Tin	3	2	4	1	3	2	1

LIMITS FOR ASSET TYPE:

Asset Type	1M	3M	6M	9M	1Y	2Y	3Y
Metal	3	4	3	5	4	3	2
Agricultural	3	2	4	1	3	2	1

Objectives:

We have to find how much should I invest in each combination asset/period to minimise the value at risk (VaR). So What we have to find is:

Asset	1M	3M	6M	9M	1Y	2Y	3Y
Nickel	?	?	?	?	?	?	?
Tin	?	?	?	?	?	?	?

Mathematical Model:

Following the process to calculate VaR using historical data we need to calculate first how much I would have invested per date.

So, let's call *hist and amount,* for historical data and amount invested, *period f*or each of the future periods and *date* for each day in the historical data table.

$$\text{amount\_period\_asset} = \sum_{d \text{ in date}} \sum_{a \text{ in assets}} \sum_{p \text{ in periods}} hist_{d,a,p} * amount_{a,p}$$

The result will be a vector of values per date, but the date is irrelevant. The daily amount of the theoretical portfolio is what interest to us.

The final objective is to minimise the 6th smaller value of this portfolio, which in a sample of 520 observations will represent 99% probability. Or, if we want to make it more generic we can minimise the 99% percentile of the vector of amounts and get the amount/period/asset combinations which result in this objective.

By using the percentile function to minimise the 99% position of the vector and this should work with any size of historical data. However, we must make sure that it minimises the left side of the bell curve.