Università degli studi di Padova

Stochastic Methods for Finance

Seventh report

Value at Risk for an equi-balanced portfolio

Author:
Lorenzo Mancini *2019098*

Professor:
prof. Martino Grasselli

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1 Goal

The goal of this report is to compute the Value at Risk of an equi-balanced portfolio, using two different methods: the parametric one and a Monte Carlo Simulation.

2 Introduction

We consider a portfolio composed by two asstes with equal proportions. This implies a dynamic behaviour in the sense that at the end of each day the portfolio needs to be re-balanced in order to mantain the proportions unchanged. The assets are:

- Tesla;
- Netflix,

and they do not provide any dividend.

2.1 Tesla

Tesla Inc. is an american company focused on the production of eletric cars, solar panels and energy storage. It is based in Palo Alto, California and its actual CEO is Elon Musk. In the following table we show some market data related to the company:

Market Cap (intraday)	**666.52B**
EBITDA	**4.55B**
Gross Profit (ttm)	**6.63B**
Closing price (April, 28, 2021)	**694.40**

Table 1: Market data of Tesla.

2.2 Netflix

Netflix is an american company that works on the distribution of multimedia content such as films, tv series and others. It is based in Los Gatos, California. Here, some data related to Netflix:

Market Cap (intraday)	**224.59B**
EBITDA	**5.71B**
Gross Profit (ttm)	**9.72B**
Closing price (April, 28, 2021)	**506.52**

Table 2: Market data of Netflix.

3 Value at Risk

As stated, the aim is to compute the Value at Risk of an equi-balanced portfolio. The Value at Risk represents the potential loss (of an investment) over a time period with a precise confidence level. We're going to consider three confidence levels (95%, 99%, 99.5%) and a list of time periods from one to one-hundred days.

3.1 Parametric

We start with 1 million dollars and we distribute half of it for Tesla shares and the other half for the Netflix ones. At the end of each day we should adjust the portfolio in such a way that the proportions are still the same. The first step is to build the portfolio: we can download the historical data for both assets from the `yahoo.com` website. After computing the daily returns we can easily construct our portfolio:

Value ($)	**returns**
1.00 M	/
0.975 M	-0.0247
...	...
1.38 M	0.0107

Table 3: Portfolio value over six months and daily returns.

The estimated volatility of the portfolio, equal to the standard deviation of the returns is:

$$\sigma_{\text{global}} = 0.0281. \tag{1}$$

Now, if T is the time horizon, the VaR is:

$$\mathrm{VaR} = \sigma_{\mathrm{global}} \sqrt{T} V_0 K, \tag{2}$$

where V_0 is the initial value of the portfolio, 1 M, and K is a factor that changes according to the confidence level considered:

- $K = 1.65$ if C.L. = 95%;
- $K = 2.33$ if C.L. = 99%;
- $K = 2.58$ if C.L. = 99.5%;

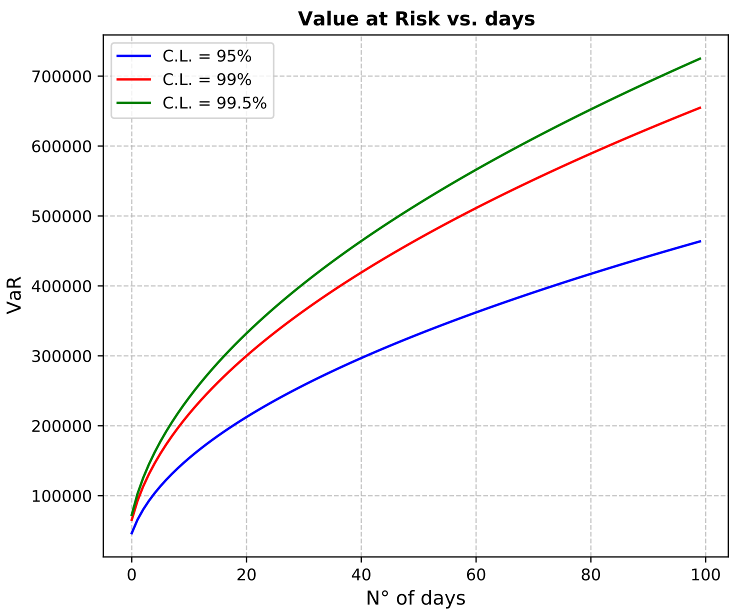

Figure 1: VaR for different time horizons (from 1 to 100 days).

It is useful also to check the additivity (non additivity) of the VaR: we compute the VaR separately for the two assets and we compare the sum with the global one.

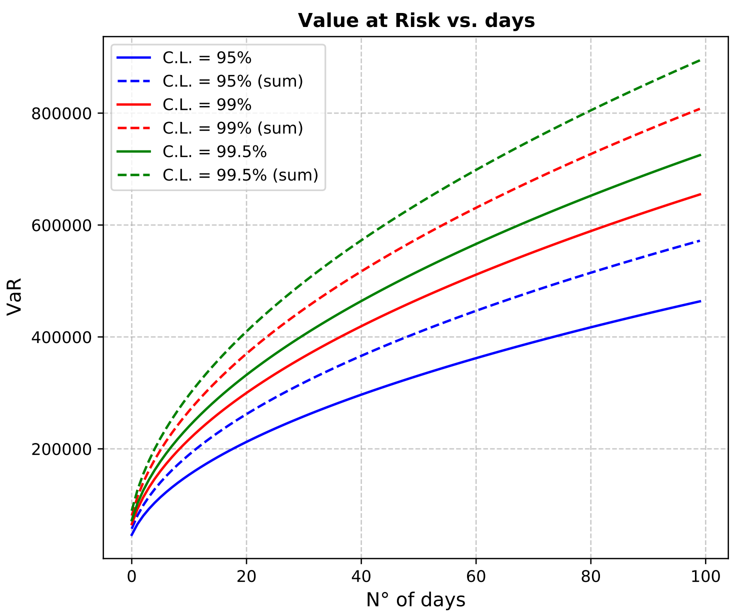

Figure 2: VaR for the global portfolio and for the sum of two portfolios (dashed lines).

As can be seen, it is convenient to invest in the global portfolio. In the following subsection we're going to do again the same computation but with a different volatility.

3.1.1 EWMA volatility

It is possible to compute the volatility of the portfolio also with the Exponentially Weighted Moving Average method:

$$\sigma^2 = \sum_{i=0}^{\infty} (1-\lambda)\lambda^i \left(r_{t-i-1} - \bar{r}\right)^2 . \tag{3}$$

For our computation we used $\lambda = 0.94$; the corresponding volatility of the global portfolio becomes:

$$\sigma_{\text{global}}^{\text{EWMA}} = 0.0228. \tag{4}$$

In the following figures we show the results obtained.

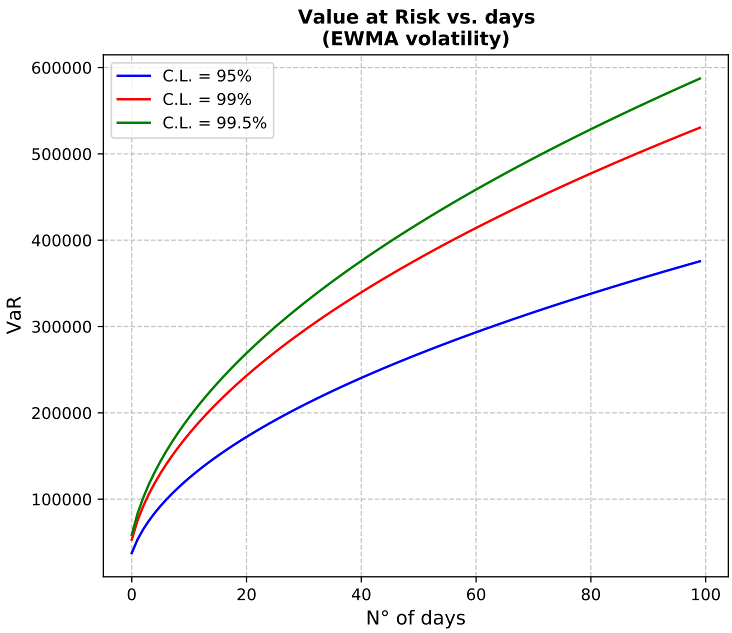

Figure 3: Value at Risk computed with EWMA volatility.

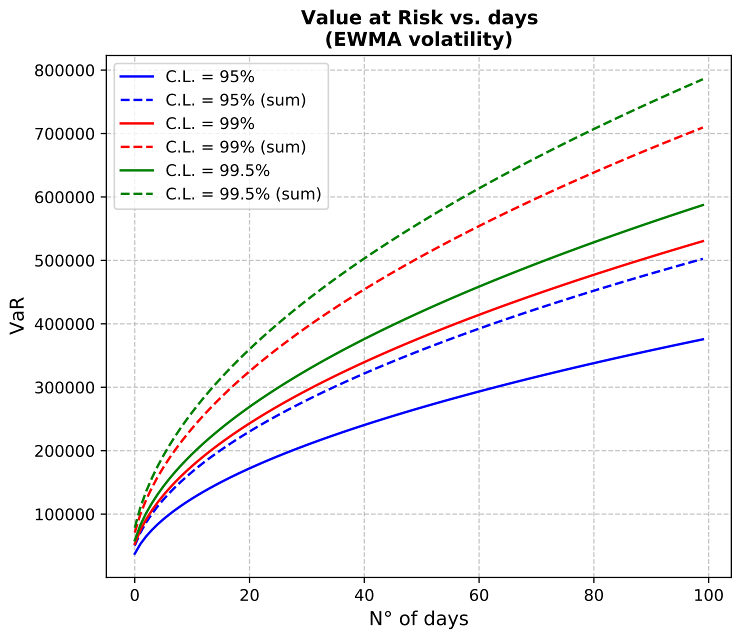

Figure 4: Comparison between the global portfolio and the sum of two single assets in the case of EWMA volatility.

Again the VaR for the sum of the two assets is always bigger than the VaR of the global portfolio.

3.2 Monte Carlo simulation

Another possibility to compute the VaR is to use a Monte Carlo simulation. It consists in the following steps:

- simulate a large number of trajectories for the portfolio value over the considered days;
- for each day compute the VaR as the difference between the initial value of the portfolio and the percentile related to the C.L. considered.

Here, we show the results.

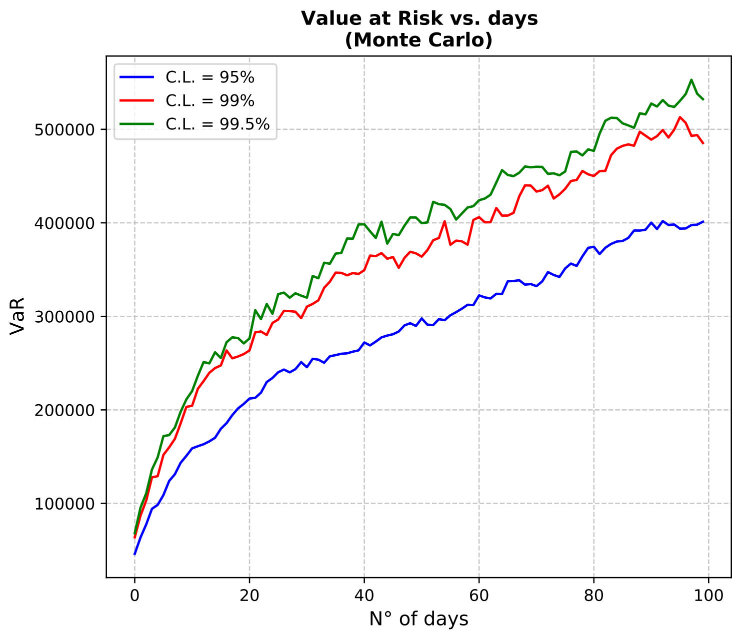

Figure 5: VaR computed with a Monte Carlo simulation

Also in this case we check the additivity (non additivity).

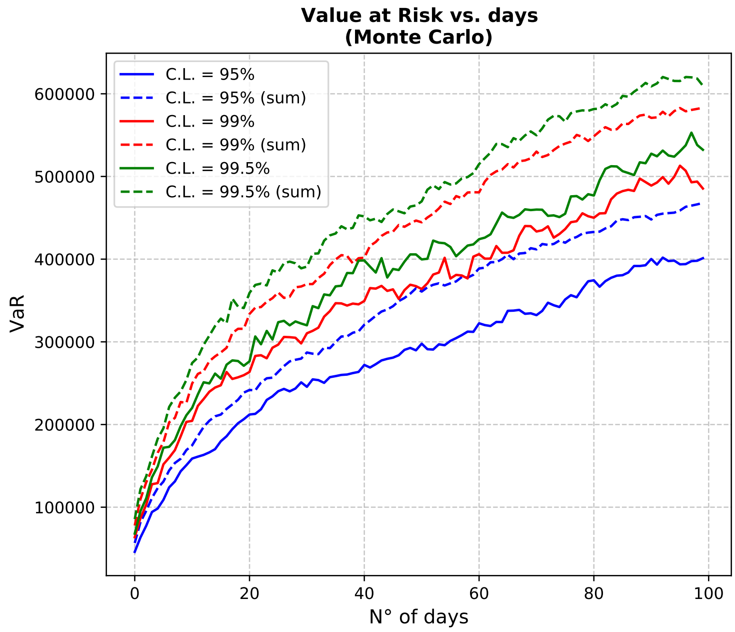

Figure 6: Comparison between the global portfolio and the sum of the two assets with Monte Carlo.

Again, we can observe that the global portfolio has a smaller risk than the sum of two single portfolios.

4 Conclusion

In this report we estimated the Value at Risk for an equi-balanced portfolio in two different ways:

- with the parametric formula;
- with the Monte Carlo simulation.

In both cases we showed the additivity (non additivity) of the VaR: in particular, in both cases we observed that the global portfolio has a smaller VaR than the one obtained with the sum of the two assets.