HW8: Risk Management

Marc Luque, NIU: 1567604
Sergi Cucala, NIU: 1570044
Carlo Sala, NIU: 1570775
Júlia Albero, NIU:1566550

Financial Engineering

Exercise 1

As in the HW2, we want to study the case of the huge drop on the $S\&P500$ on Black Monday, with the same goal on how non predictive it was, but with the main difference that now we want to measure its risk. In particular, this case is a great example of market risk measurement, which the objective is to know how much impact have the variability of the risky assets that take part in a given portfolio. The main risk measure is *Value at Risk* (VaR) which, given a time horizon T and a $\alpha-$level of confidence, is defined as the maximum likely loss on a portfolio within T time at $(1-\alpha)\%$.
In addition, it is well known that VaR risk measure can be computed in many ways. For this particular example, we may use the *Historical Simulation*. It consists on not assuming any particular distribution for a given historical set of data, but computing the risk metrics on the histograms. It is accomplished producing simulations of empirical historical distributions using combinations of them from the several risky assets. Since in our case there is only one risk asset (the one held at Black Monday) and simultaneously quantifies the value of our portfolio, we just need to measure the risk metrics on the histogram of the previous days data.
The thing is that the historical data, which in our case are the returns of the index $S\%P500$ during the 80's, can be plotted as an hypothetical Profit-and-Loss density function, and VaR would determine the maximum likely loss after some time T before excluding all the worst cases which have at most probability α.
Recall that the returns of the $S\&P500$ index time o of the previous two years of the Black Monday (included) event have the following time series:

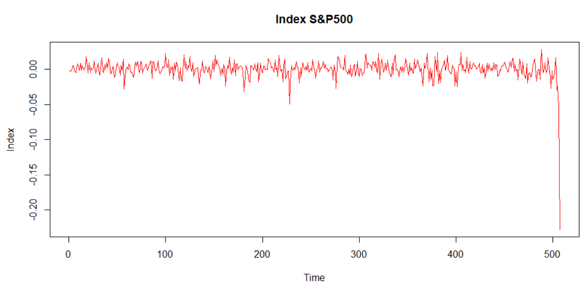

Figure 1: S&P500 index time series

Which is clear enough that was totally unexpected return from the shape of the time series during the last years. On the other hand, if we had to compute the histogram of returns excluding the risky asset we would have:

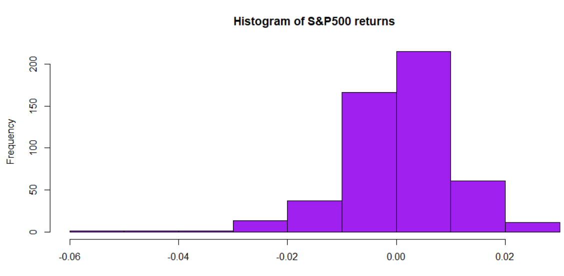

Figure 2: S&P500 index return histogram

Finally, if we set ourselves on the previous day of Black Monday, computing the VaR within $T = 1$ day horizon and 99% confidence interval, we would know the maximum likely loss after one day excluding all the worst cases which have 99% probability to be held.

```
VaR(x,0.99,method="historical")
 => VaR  -0.02734784
```

Which by far resembles the value Black Monday had of -0.2280063. This does not justify that VaR measure is not precise, but the method. Since we are not assuming any particular distribution for the returns, due the *Historical Simulation* VaR computation method we may be losing information, with only simulations. We require then a more improved way of computing the VaR, which is the *Monte Carlo Simulation.* A second hypotheses is that VaR only measures market risk value, and not so well the other kinds of risks. Taking this into account, we could say that the risk of the asset was immeasurable with VaR because the risk did not came from market value.

Exercise 2

We'll take everything we know from Exercice 1 and, following up with Monte Carlo simulations, we'll try to and set a correct price for the PUT option. Using also the Monte Carlo simulation, we were able to fix a price for that. In this case, we are going to focus the study on VaR metric, in order to adjust that price for the risk stated. We'll be considering that interest rate follow a normal distribution with mean 5% and variance 1%, and volatility follow another normal distribution with 40% and 10% respectively. Also, we'll use every other parameter the same we had on HW5.
First of all, when we read the parameters for this study, we thought that a 40% in terms of volatility was absolutely mad, and we were expecting a lot of risk.
Indeed, as we first thought, we get crazy risk for this stock. We calculated VaR in two different ways, and getting almost same results:

```
VaR(prices,0.99,method="modified")
 => VaR -0.9396245

quantile(prices, 1 - 0.99)
=> -0.9459322
```

Almost same results for tail VaR:

```
a <- quantile(prices, 1 - 0.99)
mean(prices[prices <= a]
=> -0.9734424
```

It's clearly stated that this fictional stock is absolutely uncontrollable and, defining a price for a PUT option is difficult, even more, close to impossible. Note that results for previous data depends on execution, as we are generating random parameters. Then, doing 1000 simulations, we get a median price of the PUT option of 6.384. Let's see the distribution of this prices:

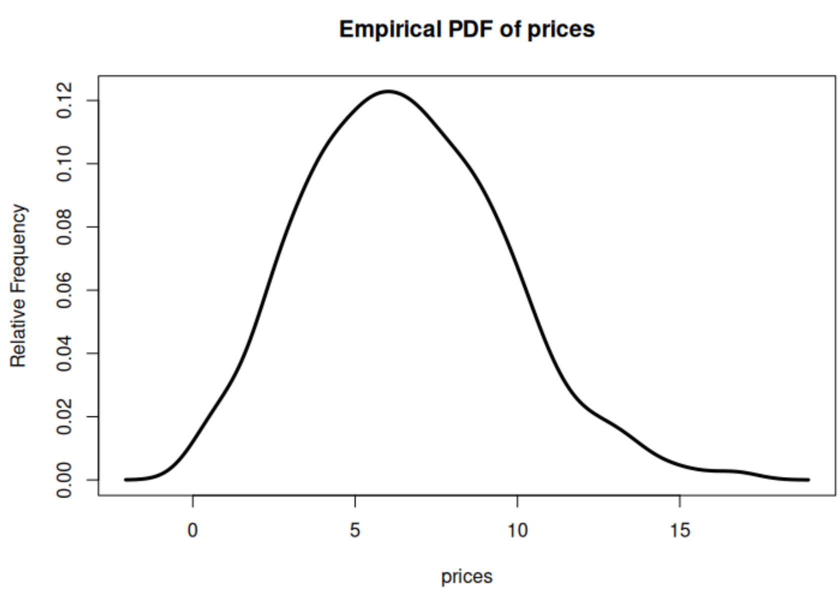

Figure 3: PUT price distribution

After this study, we might finish discarding the option of selling a sell option, and probably have anything related to this stock. Its huge volatility makes it really difficult to study and work with it.