Homework assignment 2. Programación y modelación financiera (PMF)

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Asset Pricing

Risk and return play an important role in making any investment decisions. As we know, the main focus of asset pricing theories is to determine the fundamental value of assets and there is a relation between this and an appropriate return. So, the focus of asset pricing theories is to determine this appropriate return. For this report, three U.S. stocks from different industries were selected, which are the following: Nike, Microsoft, and McDonald's Corporation. This assignment includes the last five years of monthly returns for the three individual stocks and the S&P500 stock index. The objective is to provide a comparative analysis of the relationship between asset returns and market.

Single-index model

Determining efficient portfolios within an asset class can be achieved with the Single-index model. The market return is an aggregation of all individual asset returns traded in the stock market. The Single Index Model relates returns on each security to the returns on a common index, such as the S&P500 Stock Index.

Methodology

The model suggested is: Ri = αi + βiI + ei Where: Ri = expected return on security i αi = intercept of a straight line or alpha coefficient, component proportional to the market index (βiS&P500j) βi = slope of straight line or beta coefficient I = expected return on index (S&P500j) ei = error term with the mean of zero and a standard deviation which is a constant

This model is the basis for further investigation. As mentioned before, three stocks were selected, i = 1,...3, and 69 monthly returns observations j=1,...69. Our purpose is to find αi and βi for the stocks of Nike, Microsoft, and McDonald's Corporation.

Individual Assets Returns

The stock returns of the past five years for Nike, Microsoft and McDonald's Corporation are the following:

```
## # A tibble: 207 x 3
## # Groups:   symbol [3]
##    symbol date        R_stocks
##    <chr>  <date>         <dbl>
```

```
##  1 NKE    2016-01-29  0.00796
##  2 NKE    2016-02-29 -0.00677
##  3 NKE    2016-03-31  0.000625
##  4 NKE    2016-04-29 -0.0412
##  5 NKE    2016-05-31 -0.0631
##  6 NKE    2016-06-30  0.00256
##  7 NKE    2016-07-29  0.00543
##  8 NKE    2016-08-31  0.0386
##  9 NKE    2016-09-30 -0.0840
## 10 NKE    2016-10-31 -0.0469
## # ... with 197 more rows
```

S&P500

Concerning the S&P500, monthly returns for the past five years are:

```
## # A tibble: 69 x 2
##    date        R_market
##    <date>         <dbl>
##  1 2016-01-29 -0.0360
##  2 2016-02-29 -0.00413
##  3 2016-03-31  0.0660
##  4 2016-04-29  0.00270
##  5 2016-05-31  0.0153
##  6 2016-06-30  0.000911
##  7 2016-07-29  0.0356
##  8 2016-08-31 -0.00122
##  9 2016-09-30 -0.00123
## 10 2016-10-31 -0.0194
## # ... with 59 more rows
```

Here, the S&P500 returns are merged with the three stocks, Nike, Microsoft and McDonald's Corporation, into the same variable.

```
## # A tibble: 207 x 4
## # Groups:   symbol [3]
##    symbol date        R_stocks  R_market
##    <chr>  <date>         <dbl>     <dbl>
##  1 NKE    2016-01-29  0.00796  -0.0360
##  2 NKE    2016-02-29 -0.00677  -0.00413
##  3 NKE    2016-03-31  0.000625  0.0660
##  4 NKE    2016-04-29 -0.0412    0.00270
##  5 NKE    2016-05-31 -0.0631    0.0153
##  6 NKE    2016-06-30  0.00256   0.000911
##  7 NKE    2016-07-29  0.00543   0.0356
##  8 NKE    2016-08-31  0.0386   -0.00122
##  9 NKE    2016-09-30 -0.0840   -0.00123
## 10 NKE    2016-10-31 -0.0469   -0.0194
## # ... with 197 more rows
```

```
## # A tibble: 3 x 4
## # Groups:   symbol [3]
```

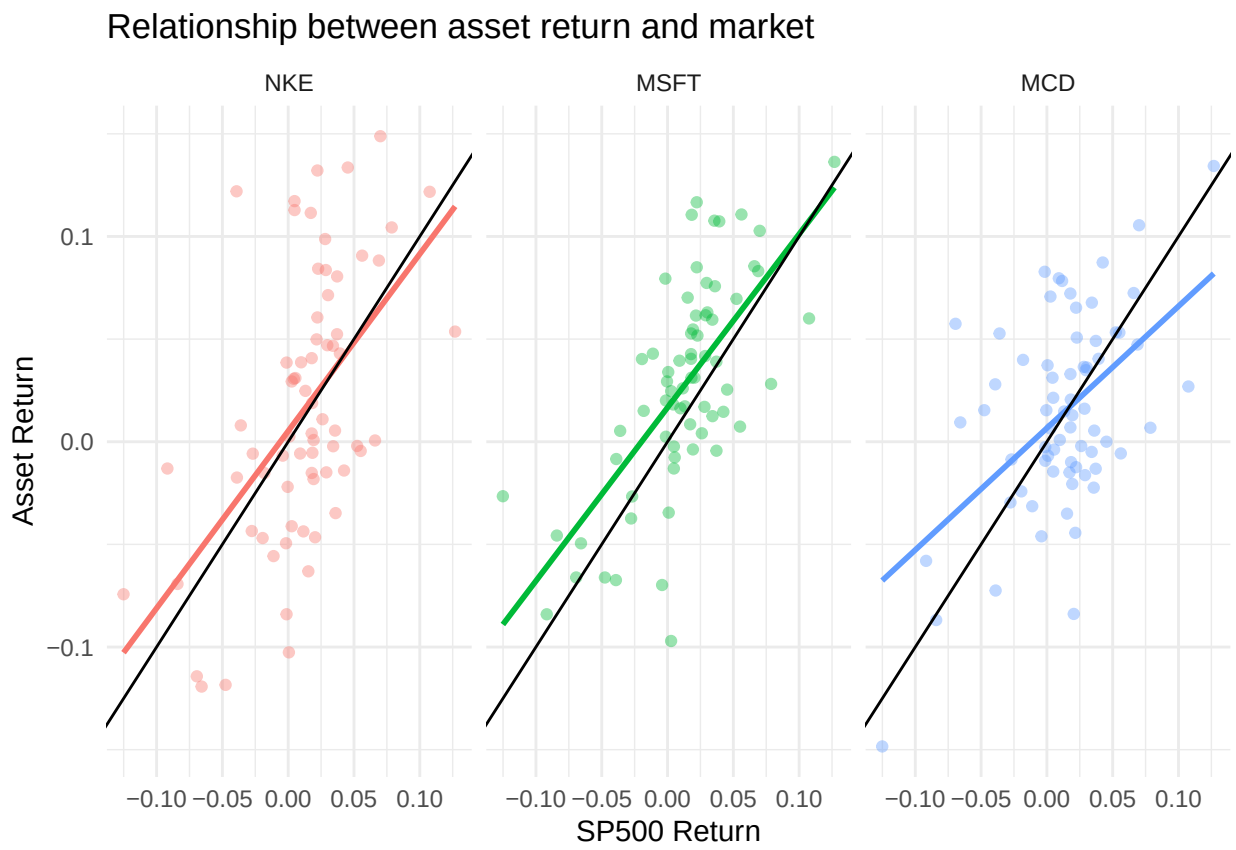
```
##   symbol  Alpha  Beta `R-squared`
##   <chr>   <dbl> <dbl>       <dbl>
## 1 NKE    0.0052 0.863       0.308
## 2 MSFT   0.0167 0.845       0.472
## 3 MCD    0.0066 0.594       0.271
```

From the above table one can observe the results for the single index model estimation for the three stocks. First, let's discuss the beta. There are stocks Beta from 0.5935 to 0.8628. This can be interpreted as a measure of the volatility, or systematic risk, of a security or a portfolio in comparison to the market as a whole. In other words, beta gives a sense of a stock market's risk compared to the greater market. β coefficient is a measure of sensitivity of a share price to movement in the market price. In this case, MCD has the lowest beta, so it is less exposed to change in the S&P500, therefore, it can be said that MCD might be exposed to other risk factors, but not at all with the market, this point will be analyzed later in the report. On the other hand, stocks with high betas, as in this case NKE, are highly exposed to changes in the S&P500. Nevertheless, the β of NKE is less than 1, which means it is less volatile than the whole market. If there was a β that is greater than 1, it would be more volatile than the market, which is not the case here.

A deeper econometric analysis is needed to validate the above interpretations. All alphas are very close to zero. The R-squared shows what proportion of changes in the stock returns are explained by changes in the stock market, the 47% of MSFT stock return changes are explained by changes in the S&P500

Let's illustrate the previous results in a graphical way.

```
## `geom_smooth()` using formula 'y ~ x'
```



NKE,MCD and MSFT are organized in a way that the slope is decreasing.The black line illustrates a stock with a slope (β) of one, which is used to visualize when a stock is riskier or less risky than the market. In

order to compare the asset return against the SP500,we graphed on the x-axis the SP500 return and on the y-axis the asset return.

MCD has the smallest R-squared, meaning the SP500 is not considered a relevant risk factor for the stock performance against MSFT and NKE.Additionally, the returns in the plot are disperse from the linear regression line for the stock which confirms there is less relationship between S&P500 and MCD returns.

On the other hand, MSFT, having the biggest R-Squared of all, has more concentrated the points(returns) from the scatter plot on the linear regression of the stock. This suggests that the SP500 returns are low, while MSFT returns are low as well. Stock returns are positively related. The β is slightly smaller than one, yet they are very close. This can be seen in the plot were both lines are almost together.

Considering the analysis above, if one anticipated a fall in the stock market, the best action would be to rearrange their portfolio investment to include more stocks of MCD and less stocks from MSFT and NKE. By doing this one could expect higher returns, since the portfolio would be doing better than the SP500.

```
## # A tibble: 3 x 4
## # Groups:   symbol [3]
##   symbol AnnualizedReturn `AnnualizedSharpe(Rf=0%)` AnnualizedStdDev
##   <fct>             <dbl>                     <dbl>            <dbl>
## 1 NKE               0.174                     0.767            0.226
## 2 MCD               0.162                     0.978            0.166
## 3 MSFT              0.352                     1.97             0.179
```

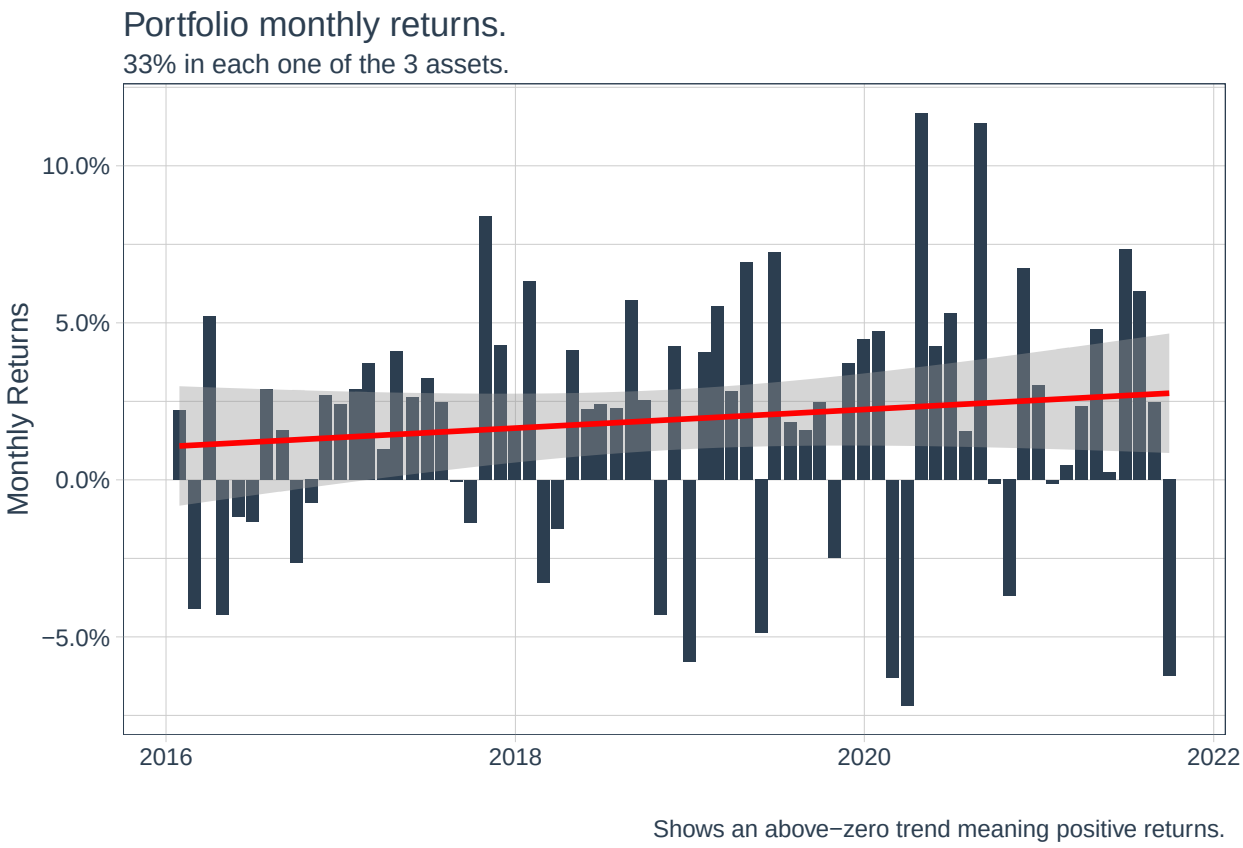
Annualized Returns with a Mean Variance Plot

The red line has 45 degrees to visualize the return per unit. If the asset is located above the red line means a return per unit of risk greater than one, which is the case for MSFT. On the other side, we have MCD almost above the line with 0.978 returns per unit of risk and NKE located below the line.

The most attractive stock is MSFT due to the high returns and low risks the stock presents in the graph. Even though, all stocks present a positive numerical value per unit of risk, MSFT looks more attractive for being on the top corner of the graph (representing a high return for a very low risk). The least attractive stock is NKE, per it is the one with the lowest return but highest risk (located in the low corner in the right side).

Portfolio Creation with Equal Weigths

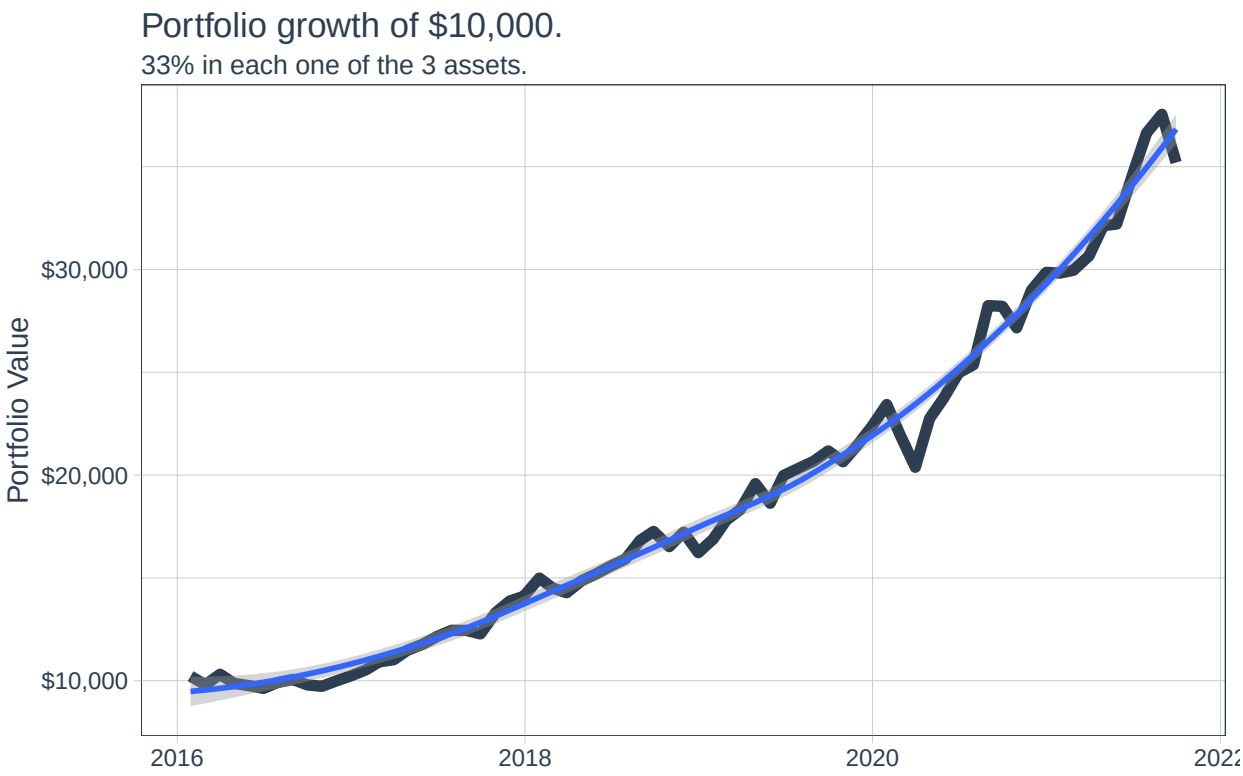
```
## `geom_smooth()` using formula 'y ~ x'
```



Based on the table of the Portfolio Monthly returns, it can be interpreted that with the portfolio having equal weight assets, the company accomplished positive returns. The returns have increased from 2016 to 2022. Therefore, the portfolio tactic was successful, the portfolio achieved to deliver returns based on the stated objectives of the investment strategy, as well as the risk tolerance of the type of investors targeted by the portfolio.

Cumulative Returns

```
## `geom_smooth()` using formula 'y ~ x'
```



As it was interpreted before, the portfolio had an increase in their returns. Based on the Cumulative Returns graph,the portfolio had an increase of almost $30,000 in the last six years. Therefore, since it is important to have a realistic expectation about that type of returns the portfolio will get. A good return on investment is generally considered to be about 7% per year, hence the portfolio of equal weight of Microsoft, McDonald's and Nike have a good return rate.

Annualized Returns

```
## # A tibble: 3 x 3
## # Groups:   symbol [3]
##   symbol `AnnualizedSharpe(Rf=0%)`  Beta
##   <chr>                        <dbl> <dbl>
## 1 NKE                          0.767 0.863
## 2 MCD                          0.978 0.594
## 3 MSFT                         1.97  0.845
```

Above, we can observe the annualized Sharpe ratios and the annualized betas of the respective three stocks, NKE, MCD, and MSFT. MCD, is the one with the smaller Beta, which is the result of MCD being considered a "defensive stock", so that in tough economic times people will still need to eat, and maybe they will not have enough money to buy a PC (MSFT), or the last fashionable sneakers (NKE) but why not a Big Mac? Simply instant pleasure, and way more cheaper than the other two options. The low Beta is also related to this, because at any time no matter the state of the economy people will still need food, therefore MCD has a more stable revenue, resulting in more stable cash flows and of course, a more stable expected return, which turns out in less volatility on the price and of course, a lower Beta, and even so, we can observe a higher Sharpe ratio than NKE, but lower than MSFT, what could be an explanation of this numbers? From our

perspective, food comes first and there is not much to do in terms of innovation on that industry (of course there is always new things to do, but we think it is more valuable for the market to innovate in computers than in burgers nowadays). Then, in today's fast evolving economy, technological devices and software might be more important to support several industries than sportswear. The expectation is that technology came to completely change our lives, which it has already accomplished, but still it can be assumed that there is more to come. For this reason of expectations and additionally of the exponential growth this industry has had in recent years, the Sharpe ratio is the highest. Comparing the three different industries, and considering the fact that we love sneakers, but would be the last thing to buy if the economy is not going as well as we want it. In this point of the analysis, we can actually have a concrete proof that our thoughts, are not unbiased, and actually match with the numbers.

Comparison between Three Portfolios

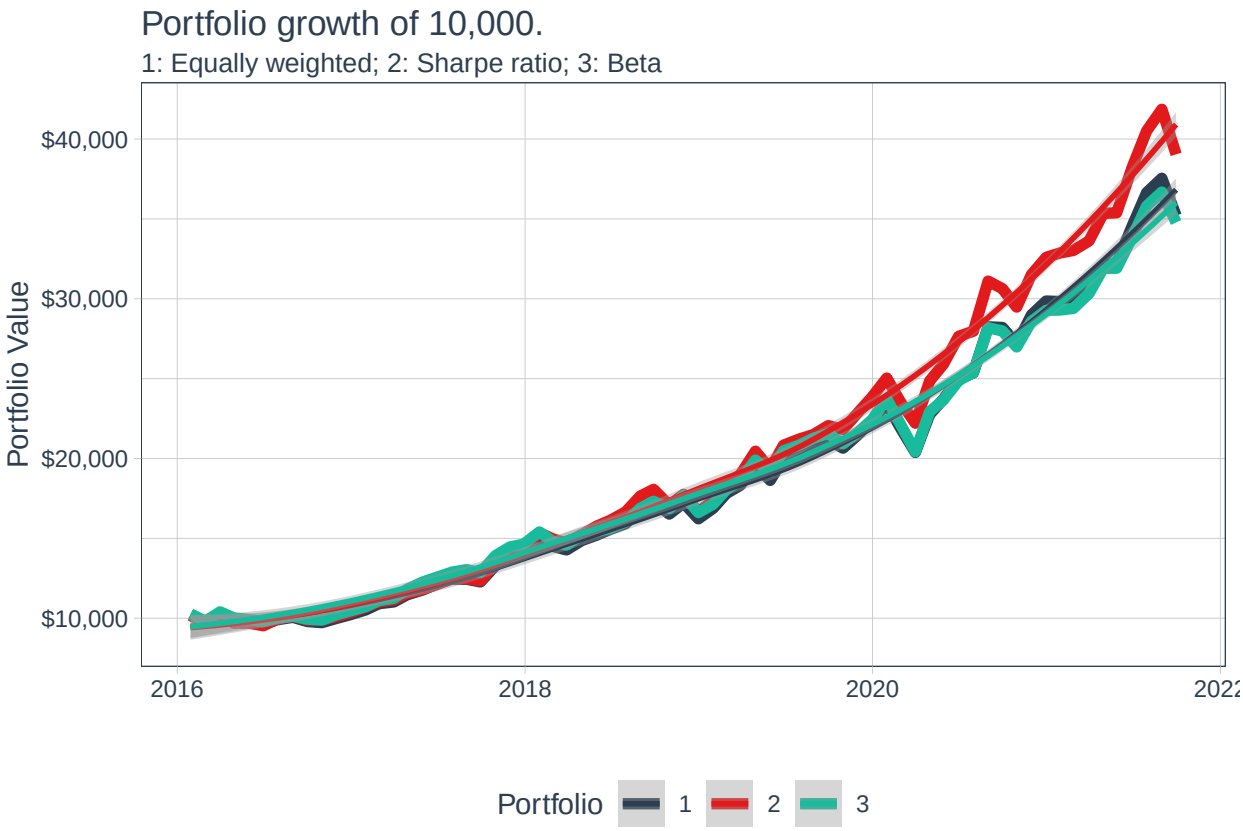
What can be seen above are three different portfolios with different weights which means that in every portfolio the stocks Nike, Microsoft and McDonald's Corporation have different weights in the portfolio. In the first portfolio, the weights are equal, for this reason, every stock weights 33.33% in the portfolio while in the second, 22.5% is assigned to Nike, 45% to Microsoft and 32.5% to McDonald's Corporation. The ranking is based on the different annualized Sharpe ratios of the companies. Since Microsoft had the highest value with 1.9690, it was ranked in first place and Nike with a Sharpe ratio of 0.7672 was ranked last. In the third portfolio the ranking was based on the stock's beta value. As a result, Nike was ranked first (45% of portfolio weight) with a beta value of 0.8628, Microsoft second (32.5% of portfolio weight) with a value of 0.8448 and McDonald's Corporation third (22.5% of portfolio weight) with a beta value of 0.5935.

In the next step, the evolution of the three portfolios will be investigated into detail.

Evolution of the Three Portfolios

```
## Ungrouping data frame groups: symbol
```

```
## `geom_smooth()` using formula 'y ~ x'
```



As we can see, there is not a great difference between every weight assigned to the assets in every portfolio since the trend of the lines are closely together. Portfolios one and three performed almost the same over the past five years, while the second one performed best from 2019 onward. The main purpose of diversification of portfolios is to diversify the risk, so if one asset goes down, the gains of another one can rescue the loss of the other. One of the things that catches one's attention is defiantly that every asset has no correlation with the other, because they are from different industries so it helps a lot when it comes to diversification.

At first, an investor can be observed who maybe was not sure about which assets were the best for greatest returns, so the decision was to go equal with all stocks. As a result, the portfolio has a return but maybe one could arrange something which results in higher returns. Then, when starting to explore the changes that the portfolio may have, taking in consideration the Sharpe Ratio of every asset since it is the volatility that they have, the weights were assigned by the way that was just mentioned. One can clearly see that the investor may be afraid of the risk, that is why there was assigned to the riskier asset the lowest weight. This second portfolio had the highest overall returns of the three scenarios. After some past experience now, in the last portfolio, the highest weights were assigned to the assets that have a greater β, in order to the principle of "higher risk, higher return". So, know this portfolio may have a great return and have a great diversification for the assets. The issue is that since it is risky, if there is a loss, the loss will be high as well. Before 2018/19, this portfolio performed best, however, experienced then higher losses as the second portfolio and therefore ended up to be the least favorable today. Nevertheless, it must be mentioned that it is close to the first portfolio and there is only a very minor difference between the two. Additionally, the second is the best option of the three, however, also here the difference is minor.

Conclusion

One can observe how a good portfolio composition can actually make the difference, giving better chances to thrive into the financial universe. If one would invest with the combination of weights assigning a higher

weight to the higher Sharpe ratio and so on, we would have the best return with the current stocks. Portfolio Management in the current stock markets, is a useful tool in order to achieve whatever one has on scope, this could be to own a diversified portfolio with a long term strategy, diminishing our Value at Risk, increasing our return in terms of risk, or to own a more audacious and fearless portfolio with a more aggressive strategy. Everything depends on what the investor really wants, to get rich or lose his money trying, or to grow his money at a steady and more slow pace. One of the most successful investors of all times said, that "diversification is a protection against ignorance" and that "It makes little sense if you know what you are doing". Even this may sound mean, it is also logical at a certain point; if you do a very deep research and are very connected with the markets and have a clear and accurate vision of the future trends, then maybe in order to maximize your returns you will look for a less diversified portfolio with an active strategy. However, portfolio management tools and analysis is with no doubt, a necessary skill and knowledge in order to achieve the investment strategy that you want in order with your goals and risk tolerance.