Portfolio Management Report

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February 2020

1 Introduction and objective

Our objective is to build a portfolio of financial assets with the aim of outperforming our benchmark. We modify our initial strategy and decide to diversify the portfolio in terms of equities.

We chose to adopt active management on 100% of the portfolio with the objective of outperforming the benchmark index (CAC 40). To select our securities, we have two approaches: the **top-down** approach or the **Botton-up** approach. The top-down approach consists of selecting high-potential sectors following a macroeconomic study and then choosing the best profiled stocks to benefit from an upward trend. The Botton-up approach consists of looking at undervalued companies, under-listed with promises of a bright future. In our active management approach we will use a top-down approach because in our opinion it is the least risky strategy. Indeed the Botton-up strategy bets on the bright future of low performing companies which is rather risky as a strategy because you need to have enough information to be able to adopt this strategy. However, the top-down strategy bets on safe market values that are constantly evolving. Since we are rather risk-averse, it is the most suitable strategy.

In what follows, we will first of all clearly define our working universe, select the assets of interest in the constitution of our portfolio by achieving diversification objectives. Secondly, we will evaluate the performance of our portfolio through certain well-known indicators, and then we will carry out a risk analysis.

Note : this report is followed by a notebook written by its authors

2 Portfolio construction

2.1 The universe

Before building our portfolio, it is important to define our universe perfectly. In this work and in relation to our investment strategy, our universe is made up exclusively of securities making up the CAC40 (30 data available out of the

40). It is important to note that the CAC40 is made up of several companies in various sectors of activity: Technology (Atos, Dassault system...), Banking (BNP, Credit Agricole...), insurance (Axa...), etc.. Understanding the trends in each sector will therefore enable us to significantly build our portfolio.

2.2 Strategy Construction

We are going to use a two stage strategy. In the first stage, we will choose the securities we put in the portfolio and only after this stage will we determine the relative weightings of each security using quantitative techniques and the modern portfolio theory. We will divide the data available to us into two parts: the first part will be used to develop our strategy and the second part will be used exclusively to evaluate the strategy implemented (Back Testing).

2.3 The first stage: securities selection

We would like to have a well-diversified portfolio to diversify into less correlated stocks. Although we invest in only one asset class, it is still possible to build such a portfolio. Indeed, a simple way to do so would be to adopt a top-down approach as mentioned in the introduction. This would diversify our sectors of activity and, a priori, reduce correlation (although another analysis is needed).

1. Base on summary macroeconomic analysis, we select the sectors with high growth potential
2. For industries where we have multiple holdings, we select the least risky ones based on the historical data available to us. We fixe, 40% as our max level of risk
3. For each sector of activity selected, we retain a maximum of 3 securities

A macroeconomic analysis shows that the following sectors have strong growth potential and would be very attractive to invest in: agri-food and mass distribution, raw materials, household and personal care products, media, community services and technology. Indeed, according to the United Nations (UN), the world population, which today stands at around 7.7 billion people, is expected to reach 8.2 billion in 2025, 9.7 billion in 2050 and 11 billion in 2100. This increase will not be without consequences. More and more people will need to be fed and cared for. Companies involved in the food and retail industries and those involved in household and personal care products will have to make more investments to cope with this demographic pressure. This demographic pressure will also require many more services to communities and especially a strong growth in Technology. We currently have 12 stocks that meet these criteria.

1. For the food industry: Danone

2. Large-scale distribution: Carrefour and Kering
3. Household products and beauty care: LVMH, Oreal and Sanofi
4. Media: Vivendi
5. Public Services: Engie, Sodexo, Veolia
6. Capgemini, Atos

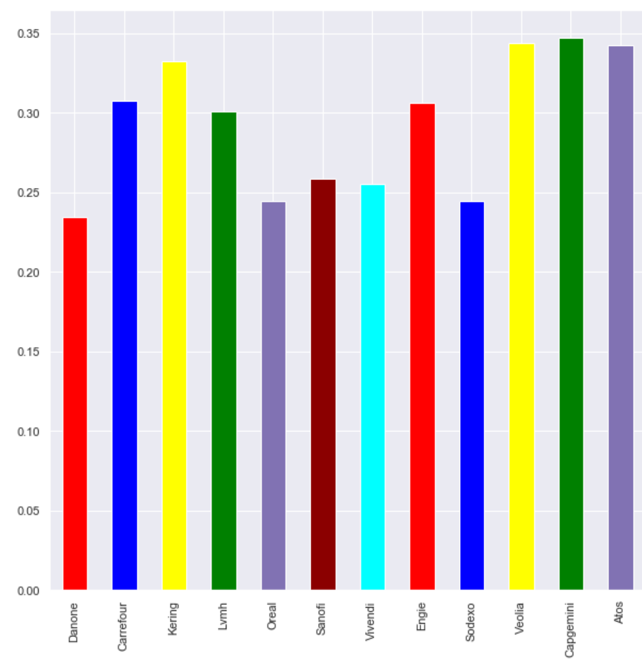

Figure 1: Annual volatily of the 12 securities selected.

Since all 12 actions meet our set level of risk, we choose them all. And if we look the covariance matrix (see the Notebook) between the returns of the differents assets.Assets are indeed highly correlated with each other, which suits us perfectly.
So we finally have in our portfolio made up of 12 shares. The historical price of the 12 shares is presented as shown in the graph above.
Now we will have to decide on the different weights to assign For each title in the portfolio.

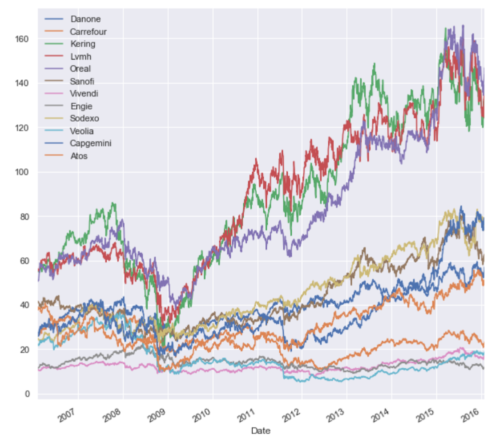

Figure 2: Historical Asset trend

2.4 The second stage: weight allocation

In this section, we will use the Modern Portfolio Theory[1]. Theory to determine the weights to assign to each security. We will use 4000 Monte Carlo iterations to generate vectors of the weights to be assigned to our titles. Each weight vector will determine a portfolio. So we will have 4000 different combinations of our titles and each combination represents a portfolio. Then for each of the 4000 portfolios, we will calculate the expected volatility, the expected return and the Sharpe ratio. We will graphically represent each portfolio in the plan (Volatility, Yield) and we also represent the efficient frontier. In the end, we will choose the portfolio which minimizes volatility and which maximizes the expected return. This simply consists to maximizing the sharpe ratio.

Indeed, if we modelise our portfolio as $P(W)$ where $W = (w_1, ..., w_{12})$ represent the weights of asset in the portfolio. Since we adopt long strategy, this condition must be verified:

$$\sum_{i=1}^{12} w_i = 1$$

Let R_i and R_p be the return of asset i in our portfolio and the total return of our portfolio, respectively. Likewise, let σ_i and σ_p be the volatility of asset i and the volatility of the portfolio, respectively.

[1]The Modern portfolio theory (MPT) is a mathematical framework for assembling a portfolio of assets such that the expected return is maximized for a given level of volatility. It is a formalization of diversification in investing, i.e., the idea that owning different kinds of financial assets is less risky than owning only one assets

the return of our portfolio is given by:

$$R_p = \sum_{i=1}^{12} w_i R_i = \mathbf{w}^T \mathbf{R},$$

where $\mathbf{R} := (R_1, \ldots, R_{12})^T$.
And the volatility of the portfolio is given by:

$$\sigma_p = \sqrt{\mathbf{w}^T \Sigma \mathbf{w}}.$$

where Σ is the is the symmetric square **covariance matrix**. In relation to this formulation, maximizing the sharp ratio is therefore consist to solving this optimization problem (we put the risk free rate at zero).

$$min \frac{R_p}{\sigma_p}$$

subject to

$$\mathbf{w}^T \mathbf{1} = 1, 0 \leq \mathbf{w} \leq 1$$

The result of the optimisation give us :

Maximum Sharpe Ratio portfolio		
return	volatility	sharpe ratio
9.24%	22.02%	0.42

After the simulation, we obtained this scatter plot below. We have also add two important portfolios: the portfolio with the Global Minimum Volatility (GMV), and the portfolio with the Maximum Sharpe Ratio (which is exactly the portfolio we're interested in).To do that we use a specific module in python (cf. the notebook).

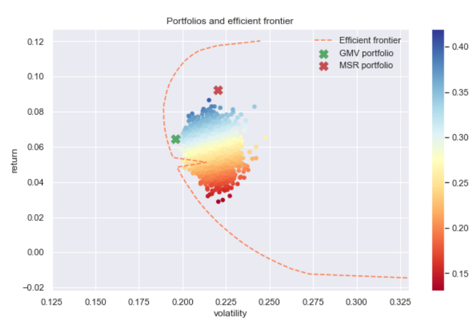

Figure 3: Scatter plot of Monter Carlo Simulation of 4000 portfolios and efficient frontier

The weight distribution obtained is as follows: We can see that weight is

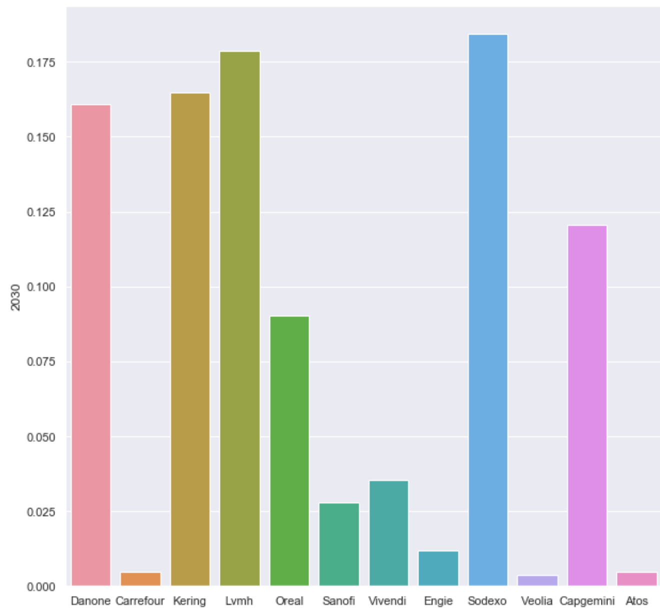

Figure 4: The weight distribution of our Maximun sharpe ratio

concentrated in 4 companies : **Danone**, **Kering** , **LVMH**, **Sodexo**

Greater weighting of securities in the portfolio			
Danone	Kering	LVMH	Sodexo
0.16	0.164	0.17	0.18

Other approach : Optimizing our portfolio by hand - different to the Monter carlo simulation
Here, we compute the optimization problem by hand (We create our own function). Note that scipy offers a **minimize** method, but not a **maximize** method, and we may then conclude that we are not able to find such a portfolio by solving an optimization problem. However, **the maximization of the sharpe ratio is nothing but the minimization of the negative sharpe ratio**.

Maximum Sharpe Ratio portfolio - Hand Method		
return	volatility	sharpe ratio
11.53%	21.05%	0.55

If we plot the distriution of the weight, We see that is concentrated in 3 companies : **Oreal**, **Sodexo** and **Capgemini**

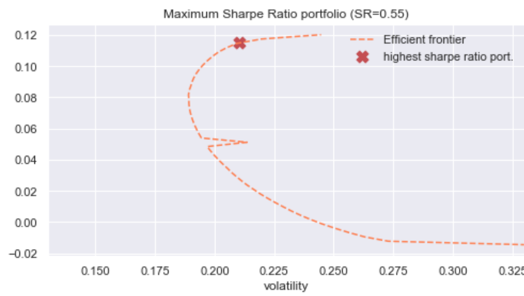

Figure 5: Maximun Portfolio and efficient frontier of the Hand optimization

Greater weighting of securities in the portfolio		
Oreal	Sodexo	Capgemini
42.84%	56.68%	0.48%

Since we obtain the zero weights for the other securities, we will only keep in the portfolio the 3 non-zero weight companies (Oreal, Sodexo and Capgemini). Also, the characteristics are much better than those obtained with the Monter carlo simulation. This can be explained by the fact that with Monter carlo you have to do a lot of simulation to find all of the possible portfolios (normally an infinity as the weights are between 0 and 1).

3 Portfolio Performance analysis

In this section, we will perform the performance analysis of our portfolio. We will assess our investment strategy over 5 years from the end of the historical data used. This analysis will be done in two parts:

1. We will compare the performance of our portfolio and that of our benchmark over the entire period
2. We will compute the Treynor Ratio

1: Portfolio Holding period

We decide to hold this portfolio for a period of two years (29/01/216 to 30/11/2017). We also invest our initial capital (100,000 Euro). The capital shares of each company are shown in the following table:

Invesment caapital shares of each company (Euro)		
Oreal	Sodexo	Capgemini
42840	56680	480

2: Evolution of portfolio returns over this period and also a CAC

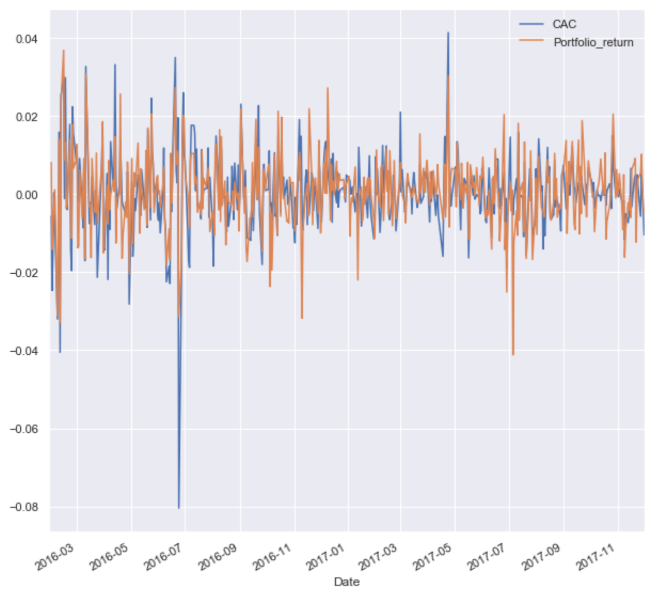

Figure 6:

If we annualize the return and put them into the table, we can see that globaly our portfolio do better than the cac 40 during the holding period.

Annual Returns	
CAC	Portfolio
0.70%	0.83%

3: Treynor's ratio

Treynor's ratio is used to analyze the performance of a portfolio in terms of volatility and underlying risk. The special feature of the Treynor ratio is that it analyzes the relative volatility of the portfolio compared to a benchmark index. This ratio is therefore perfectly adapted to measure the performance of our study. The Treynor ratio is the ratio between the relative performance of risk-free rates and the beta of the portfolio, compared to the benchmark(reference index).

If R is the expected return on our portfolio, R_f is the risk-free investment rate, and β the "beta" of the portfolio Treynor's ratio is calculates as follows:

$$T = \frac{R - R_f}{\beta}$$

To compute the T we need to compute the β first.

Beta is a volatility or sensitivity coefficient expressing the relationship between fluctuations in a security and market fluctuations. The goal is to define the correlation between a security and the index to which it belongs. To calculate beta, we need to regress the series of returns in our portfolio to the series of market returns. We unravel our universe with a one-factor model. Where β is given by the following formula:

$$\mathbb{E}[R] = \beta \mathbb{E}[r_m], \qquad \beta := \frac{\mathrm{Cov}(R, r_m)}{\mathrm{Var}(r_m)},$$

So all we have to do is to regress our portfolio return to Cac return to get our beta (we use OLS regression, see the notebook). After the regression we get $\beta = 0.66$
so the Treynor's ratio using the formula above give : 1.26%
The ratio is positive although low. The investment strategy improves the return taking into account the risk. Indeed, the higher the Treynor ratio, the better the profitability obtained with regard to the risk incurred.
In fact, at the end of the year, we achieve a higher return on investment than the CAC 40 would have given us (precisely 840e out of the 100,000e invested.).

4 Risk Analysis

In this section, we analyze the risks from beta β and VaR(Value at Risk).

4.1 The beta (β)

The β value calculated on our portfolio is 0.66 This means that the movements of our portfolio have a volatility equal on average to 66% of the CAC40 volatility, upwards or downwards. Our strategy therefore reduces the risk almost by half.

4.2 The Value At Risk

The Value-At-Risk represents an investor's maximum potential loss in the value of an asset or portfolio of financial assets that is expected to be achieved only with a given probability over a given time horizon. It is, in other words, the worst expected loss over a time horizon given for a certain level of confidence.

Mathematically, the VaR is defined as follow. Given the confidence level $\alpha \in (0, 1)$,

$$\mathrm{VaR}_\alpha := -\inf\{x \in \mathbb{R} \,:\, \mathbb{P}(R \leq x) \geq 1 - \alpha\} = -\inf\{x \in \mathbb{R} \,:\, \mathbb{P}(R \geq x) \leq \alpha\},$$

that is, it is nothing but that the **$(1-\alpha)$-quantile** since we effectively want to find the number VaR_α such that

$$\mathbb{P}(R \leq -\mathrm{VaR}_\alpha) = 1 - \alpha,$$

which says that there is a $(1-\alpha)\%$ probability of having a (negative) return greater or equal to $-\mathrm{VaR}_\alpha$.

There are several ways to determine VaR. We will use the non-parametric approach (Hetorical method). In In this approach, we will use historical data before to the holding period of the portfolio. The non-parametric VaR of our portfolio corresponds to the maximum loss of the portfolio.
We obtained this following historical VaR.

Portfolio Historical VaR		
$\alpha = 95\%$	$\alpha = 95\%$	$\alpha = 99\%$
1.45%	2%	3.5%

5 Conclusion

In the end, our goal was to invest for the long term (over 10 years, which we finally reduced to 2 years). To invest in CAC 40 companies and to diversify our portfolio. We also wanted to maximize our gains and reduce our risk as much as possible. And we also wanted our portfolio to outperform the CAC 40 (the index of our market). Although the performance of our portfolio is weak. We can say that our objective has been globally achieved because it is good that the CAC 40 and above all it is profitable.
The construction of our portfolio can be improved in several ways. We can indeed reconsider our initial idea which was to diversify the asset classes. Otherwise, given that we invest in the equity market, a dynamic strategy could have been better adapted, using new methods such as reinforcement learning or deep learning.

References

[1] De Jong Marielle.Portfolio Management Course. Ecole Centrale Marseille

[2] Coursera - Introduction to portfolio construction and analysis with python. EDHEC Bussiness School

[3] For the code, we used the risk_kit module present in the course Coursera given by the EDHEC Bussiness School. However we will share it with our code. This report will be accompanied by a txt file and a Notebook