

Politecnico di Milano

Computational Finance

Technical Report

Asset Allocation
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1 Portfolio Composition @ 28/10/2020

The portfolio composition for the previous two weeks is entirely based on qualitative analysis which was already displayed in the previous report and we decided to reshew them here for completeness.

1.1 Composition

Ticker	Description	Sector	Exchange	Weights
AMZN	Amazon.com, Inc	Consumer Discretionary	Nasdaq	5%
MSFT	Microsoft Corporation	Technology	Nasdaq	4%
ZM	Zoom video communications, Inc	Communication Services	Nasdaq	4%
9988.HK	Alibaba Group Holding Limited	Consumer Cyclical	HKSE	4%
6758.T	Sony Corporation	Technology	TYO	6%
ENPH	Enphase Energy, Inc	Energy	Nasdaq	4%
MRNA	Moderna, Inc	Health Care	Nasdaq	7%
MC.PA	LVMH Moët Hennessy - Louis Vuitton Société Européenne	Luxury Goods	EPA	6%

Ticker	Description	Exchange	Weights
CWBFX	American Funds Capital World Bond Fund Class A	Nasdaq	40%
0P0000ZZBQ	Blackrock European Dynamic Fund Fd Accumulation	LSE	10%
BAFWX	Brown Advisory Sustainable Growth Fund Institutional Shares	Nasdaq	10%

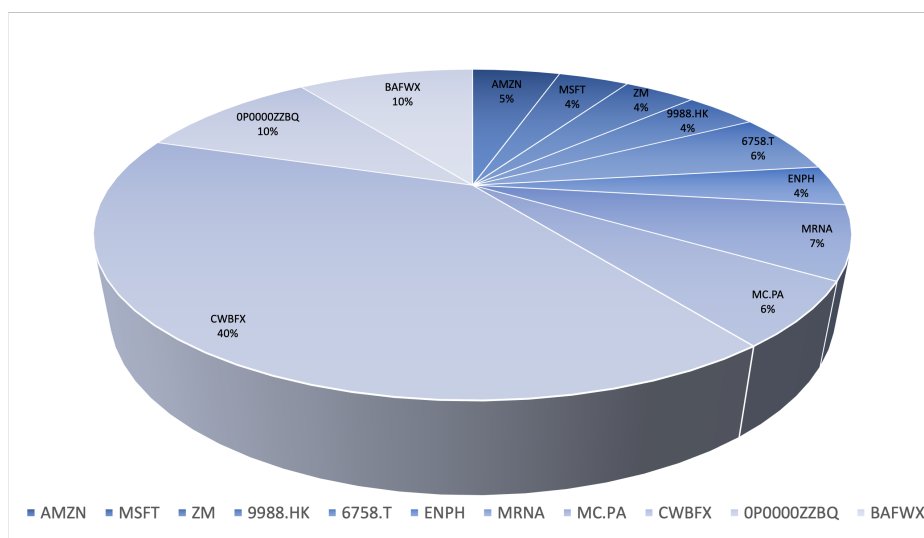


Figure 1: Portfolio Composition

1.2 Details

1.2.1 Video call platforms

To enhance collaboration from afar a number of organizations are using video conferencing tools such as **Zoom (ZM)** and many others. These services offer all-in-one team communication in place of the traditional in-person office environment. As said by Zoom founder and CEO Eric Yuan: "Organisations are shifting from addressing their immediate business continuity needs to supporting a future of working anywhere, learning anywhere, and connecting anywhere on Zoom's video-first platform".

Right now, with the constant increase in infections from COVID-19, the government could introduce new restrictions that could lead to a new rise in Zoom shares.

1.2.2 Technology

Bill Gates announced that his tech giant, **Microsoft (MSFT)**, had revenues of no less than \$37.2 billion in the third quarter of 2020. An increase of 12% over the same period of 2019 that has to do with the changes that companies and people had to make because of the virus. The change imposed by the pandemic and subsequent closures, that have affected a large part of the world's population, has proved extremely beneficial to the finance of the technology giant. The increase in home work and online learning, has led to quarterly results that are well beyond the goals of Microsoft investors. The big movement observed this year was the shift to cloud computing, which led Microsoft's technology platform, Azure, to accelerate. This is part of a general trend, as cloud storage systems from other companies such as Amazon.com Inc have also grown.

1.2.3 Politics - US Election

The American Election Day is Tuesday 3 November, regardless of the outcome of the vote, the US presidential elections have always had a high impact on the financial market and the global economy. If predicting who will win the elections is impossible, it is easier to draw the picture of the scenarios of reaction of the financial markets to the outcome of the vote.

On one side Biden's victory could lead to greater regulation in the energy, telecommunications and technology sectors, increasing business costs. While investments in the health, green economy and infrastructure and healthcare sectors could increase, the securities of the financial sector could be among the most exposed.

On the other hand, some experts believe that the reconfirmation of Trump to the White House would increase the S&P 500 index by 5%, having been the current president a "Good Friend" of the American financial system.

Given the current political situation we decide to diversify our portfolio by investing in companies listed in S&P 500 (**AMZN**, **MSFT**) and in the green and health sector (**ENPH**, **MRNA**).

1.2.4 Healthcare

Due to the COVID-19 pandemic, right now, nearly everyone in the healthcare investment world is talking about **Moderna (MRNA)**. The biotech company, thanks to \$1.1 billion received from governments all over the world, is actively preparing for launch of COVID-19 vaccine. Lately Moderna Inc. said it is on track to report early data from a late-stage trial of its experimental COVID-19 vaccine, offering the clearest timeline yet for when the world will know whether it is effective.

Moderna's CEO Stéphane Bancel said "I believe that if we launch our Covid-19 vaccine, 2021 could be the most important inflection year in Moderna's history. We will".

Moderna CEO Bancel expects interim results from its COVID-19 vaccine trial in November and said the US government could give an emergency use node in December - as reported in the Wall Street Journal.

1.2.5 Green Economy

During the sanitary emergency the green enterprises have used more the digital one, have innovated more, have made formation, have invested in research and development. They have more positive expectations about the recovery, they are more optimistic than the others and believe to recover within 1-2 years the levels of activity preceding the crisis. Who has invested in the green has been strengthened thus we try to invest in **Enphase Energy Inc (ENPH)** company. Moreover, confident in the development of sustainability business, we also choose **Brown Advisory Sustainable Growth Fund** which implements environmentally sustainable strategies to drive earnings growth.

1.2.6 European and Asian markets

To reduce risk and exposure to the American market, we add to our portfolio shares and funds from European and Asian markets.

Following the same reasoning as above, we expect the e-commerce to grow and thus the choice of **Alibaba Group (9988.HK)**. **Sony Corporation (6758.T)** is set to launch new products in November which can increase its value in a short-term period. We think that for the European market **LVMH (MC.PA)** can be a good choice since it obtained very good results in the past years and most of the largest European funds have in their portfolios shares of the company; moreover in these days the company has found a deal for the purchase of Tiffany & Co. enhancing the brand. For what concerns the funds, we invest in **Blackrock European Dynamic Fund** which has in its total assets a majority of equity securities of companies listed in Europe with good growth potential.

1.2.7 Fixed Income - Bonds

Until now we have in our portfolio only equities and funds which invest mainly in equities so we add a fund related to the bond market in order to have riskless assets. **American Funds Capital World Bond Fund Class A** carries out the task by investing primarily in sovereign and corporate bonds in more than 60 developed markets.

1.3 Funds Composition

1.3.1 American Funds Capital World Bond Fund Class A (CWBFX)







Sectors	Fund %
 Government	58.93
 Municipal	0.13
 Corporate	30.21
 Securitized	4.05
 Cash & Equivalents	6.68
 Other	0.00

Figure 2: Sector Weightings (%)

Holdings	% Portfolio Weight
China (People's Republic Of) 3.86%	1.60
Japan (Government Of) 0.1%	1.58
United States Treasury Notes 0.62%	1.24
Japan (Government Of) 1.2%	1.14
Japan (Government Of) 0.1%	1.09
Mexico (United Mexican States) 7.5%	1.08
Greece (Republic Of) 1.5%	0.94
Canada (Government of) 2.25%	0.87
Nykredit Realkredit A/S 0.5%	0.85
Serbia (Republic Of) 3.12%	0.83

Figure 3: Top Holdings

1.3.2 Blackrock European Dynamic Fund (0P0000ZZBQ)

	Sectors	Fund %
Cyclical	 Basic Materials	7.93
	 Consumer Cyclical	18.86
	 Financial Services	9.01
	 Real Estate	2.72
Sensitive	 Communication Services	1.19
	 Energy	1.32
	 Industrials	18.54
	 Technology	22.00
Defensive	 Consumer Defensive	0.97
	 Healthcare	14.37
	 Utilities	3.09

Figure 4: Sector Weightings (%)

Holdings	% Portfolio Weight
LVMH Moet Hennessy Louis Vuitton SE	5.32
ASML Holding NV	4.99
Lonza Group Ltd	4.85
Sika AG Registered Shares	4.34
DSV Panalpina AS	4.15
SAP SE	4.11
Novo Nordisk A/S B	3.92
Volvo AB B	3.49
Safran SA	2.96
Worldline SA	2.88

Figure 5: Top Holdings

1.3.3 Brown Advisory Sustainable Growth Fund Institutional Shares (BAFWX)

	Sectors	Fund %
Cyclical	 Basic Materials	2.29
	 Consumer Cyclical	18.04
	 Financial Services	4.19
	 Real Estate	4.11
Sensitive	 Communication Services	3.71
	 Energy	0.00
	 Industrials	5.79
	 Technology	37.34
Defensive	 Consumer Defensive	0.00
	 Healthcare	24.54
	 Utilities	0.00

Figure 6: Sector Weightings (%)

Holdings	% Portfolio Weight
Microsoft Corp	4.88
Danaher Corp	4.85
Amazon.com Inc	4.75
Thermo Fisher Scientific Inc	4.20
Visa Inc Class A	4.10
American Tower Corp	4.02
Intuit Inc	3.86
UnitedHealth Group Inc	3.84
Alphabet Inc A	3.64
Verisk Analytics Inc	3.55

Figure 7: Top Holdings

2 Benchmark Composition

Ticker	Description	Weights
MIWO000000PUS	MSCI World	60%
AGGH	iShares Core Global Aggregate Bond UCITS ETF	40%

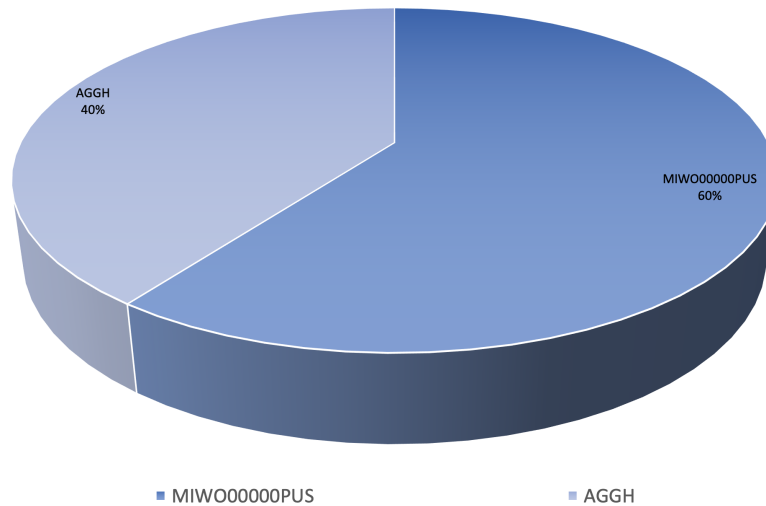


Figure 8: Benchmark Composition

Regarding the benchmark, we opted for a mix of two indices; a broad equity index and an aggregate bond index since our portfolio is mainly composed by these kind of instruments.

The **MSCI world** index is commonly used as benchmark as it includes a collection of stocks of all the developed markets in the world.

The **iShares Global Aggregate Bond UCITS ETF** seeks to track the results of **Bloomberg Barclays Global Aggregate Bond Index**. To reply the results the iShares ETF performs a direct investment in government, government-related, corporate and securitized bonds with an exposure to investment grade bonds. We decide to use the ETF as benchmark since the historical data of the index are not available.

3 Performance analysis

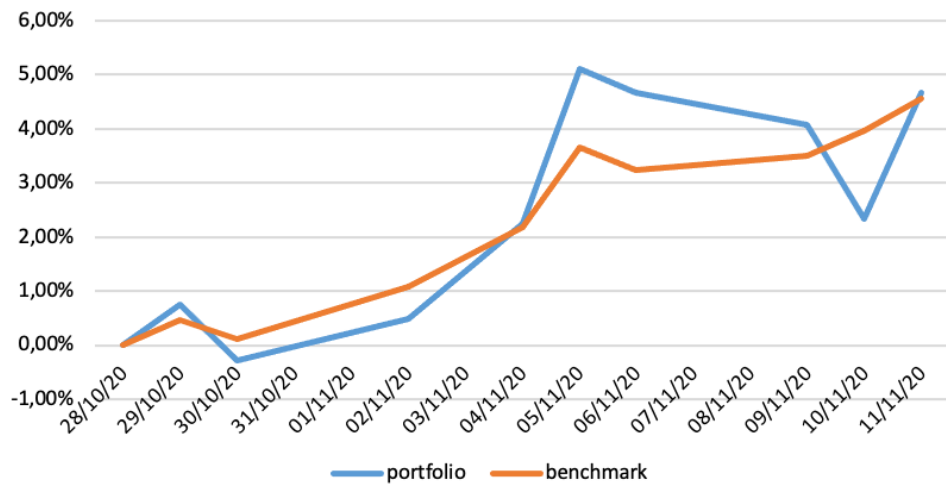


Figure 9: Cumulative Performance

In absolute terms we can state that our portfolio had a good performance, since at the end of the period we obtained a return higher than the 4% and, in general, we kept a return greater than 0 at almost every day, with a peak of the 5%.

On average we managed to beat the benchmark, with an information ratio:

$$IR = \frac{\mathbb{E}[r_p - r_b]}{\sigma[r_p - r_b]} = 0.01932$$

We can say that in the first half we obtained results in line with it; more precisely until the 4th November our portfolio remained consistent to the benchmark. During 5th we better performed, then we were worse; in fact in the period 6th-11th November our portfolio and the benchmark registered two different trends except for the last day when we managed to recover our losses of the previous days.

More precisely, the peak on the 5th November is due to the fact that all our stocks had positive returns (as we can see in the table below); in particular **Enphase**, dragged by the news about the US elections, and **Alibaba** which regained some of the losses of the previous day due to the unsuccessful IPO of a company controlled by the founder of **Alibaba**.

AMZN	MSFT	ZM	ENPH	MRNA	MC.PA	6758.T	9988.HK
2.75%	3.45%	2.95%	13.53%	2.65%	3.54%	4.03%	6.53%

CWBFX	0P0000ZZBQ	BAFWX
1.10%	2.97%	2.39%

In the following days we had bad performances due to the news about the effectiveness of a vaccine for the Covid-19 since our portfolio is composed mainly by companies related to the "stay at home economy", while only **Moderna** and **LVMH** were positively effected.

On November 10th this trend worsened and moreover the Chinese regulators published new rules aimed at preventing the monopoly of online operators causing the stocks of **Alibaba** to plummet. These are the returns of the day:

AMZN	MSFT	ZM	ENPH	MRNA	MC.PA	6758.T	9988.HK
-2.92%	-2.84%	-8.50%	-6.05%	-1.63%	1.10%	-4.96%	-4.54%

CWBFX	0P0000ZZBQ	BAFWX
0.41%	-3.17%	-1.72%

On the last day, the 11th November, the effect of the new rules still heavily effected the Chinese giant of e-commerce but all the other positions regained the losses of the previous day generating thus a new positive spike for our portfolio.

AMZN	MSFT	ZM	ENPH	MRNA	MC.PA	6758.T	9988.HK
3.75%	3.00%	10.33%	10.50%	8.80%	2.83%	2.61%	-9.56%

CWBFX	0P0000ZZBQ	BAFWX
0.27%	1.53%	2.63%

4 Portfolio Composition @ 12/11/2020

4.1 Composition

Ticker	Description	Sector	Exchange	Weights
AMZN	Amazon.com, Inc	Consumer Discretionary	Nasdaq	3.25%
MSFT	Microsoft Corporation	Technology	Nasdaq	3.25%
ZM	Zoom video communications, Inc	Communication Services	Nasdaq	6.5%
6758.T	Sony Corporation	Technology	TYO	9.75%
ENPH	Enphase Energy, Inc	Energy	Nasdaq	13%
MRNA	Moderna, Inc	Health Care	Nasdaq	13%
MC.PA	LVMH Moët Hennessy - Louis Vuitton Société Européenne	Luxury Goods	EPA	13.65%

Ticker	Description	Exchange	Weights
CWBFX	American Funds Capital World Bond Fund Class A	Nasdaq	35%
0P0000ZZBQ	Blackrock European Dynamic Fund Fd Accumulation	LSE	1.3%
BAFWX	Brown Advisory Sustainable Growth Fund Institutional Shares	Nasdaq	1.3%

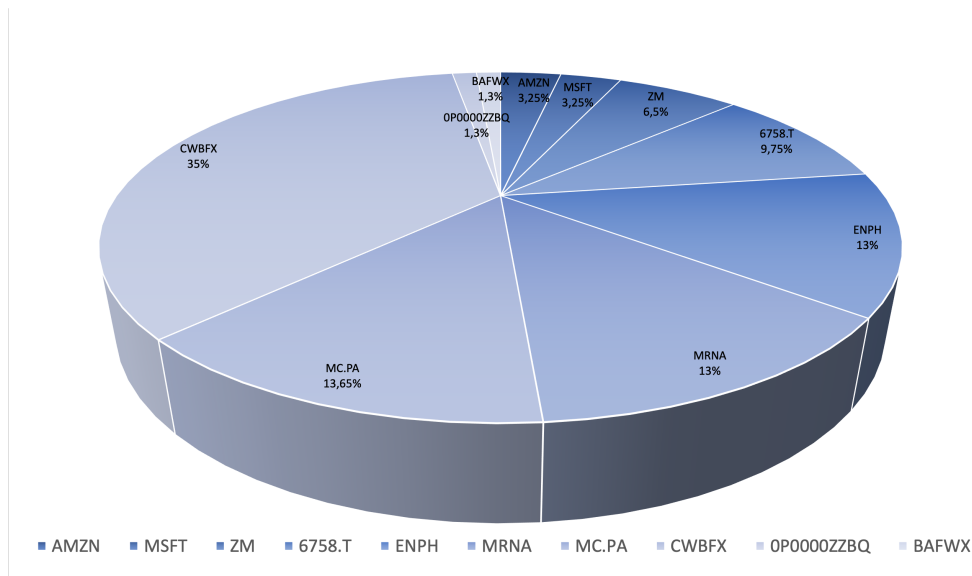


Figure 10: Portfolio Composition

4.2 Details

Starting from Thursday 12/11/2020, following the events of the previous two weeks, we change the composition of our portfolio. Therefore we both perform a qualitative analysis based on economic/political/financial news and a quantitative one. We decide, clearly, to rely more on the qualitative intuition since the algorithm that performs the analysis is heavily influenced by the exceptional results of the last months and thus the current situation can't be explained by the past data at our disposal.

Moreover we opt for a riskier approach by proceeding in this way: we decrease our exposure to the bond fund **CWBFX** by 5%. Even if it is our unique fixed income holding and its weight is bound by the benchmark composition, we choose a relative small offset (this consideration will be deepened later in section 5).

We also increase, within the equity holdings, the weights of the companies which, in our opinion, may guarantee in the next weeks higher returns even if they are more volatile.

In the previous period we had stakes in **Alibaba Group**. Despite the awaited triumph of sales in Single's day, in the last week the stock plummeted. On November 3rd, the Shanghai Stock Exchange has announced the decision to suspend the IPO waited for Thursday 5th of Ant Group, a company controlled by the founder of **Alibaba**, because of a change in the regulatory environment. On Wednesday 4th November, the company itself saw its shares collapse by almost 10% in Hong Kong. Moreover between 9th and 11th November, the company lost more than the 12% of its capitalization since Chinese regulators published draft rules aimed at preventing monopolistic behavior by online operators. In order to avoid possible new crashes, we decide to sell all our positions in **Alibaba** and to reinvest our money in companies that in our opinion are less risky.

The numerical study is carried out by the Matlab code `scriptResamplingShrinkage.m` which computes the optimal portfolio frontier using different estimators for the mean and the covariance of portfolio's return.

The optimization has been performed on all our instruments but the bond fund **CWBFX** since its weight is fixed because of the constraint (see section 5 for more details).

Our historical data go backward about a year and a half (until 24/04/2019).

In particular we focus on the resampled frontier method since it provides as result a more diversified portfolio and moreover the estimate is more reliable since the variation of the weights along the frontier is smoother.

We remark that originally we performed the quantitative analysis also considering **Alibaba**. As we expected, the algorithm tells us to keep some positions in the company due to its high returns in the last year because of the blow out of the e-commerce during the pandemic. However, following our future expectations supported by recent events, we sell all the stocks we had in the company.

Therefore we add the numerical analysis we worked on, without considering **Alibaba**.

Firstly we compute a boxplot of our historical data to better visualize them.

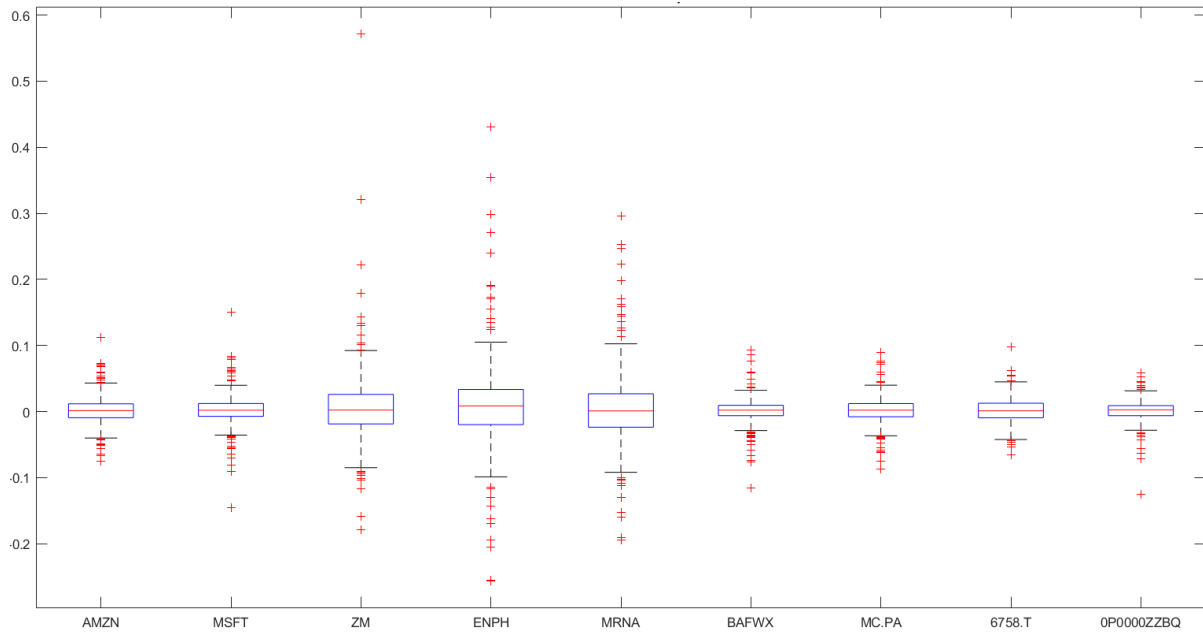


Figure 11: Historical data - boxplot

Looking at figure 11, we see possible outliers in **Zoom**, **Enphase** and **Moderna**, so we decided to check whether these returns actually happened or not. This research ended up in finding that these were not errors in the dataset but a situation really observed in the market.

We can also see how these three companies, as we can expect, are the most volatile ones while the other firms, since already established in the market, and the funds guarantee less volatility.

Then, we compute 25 portfolios on the resampled frontier and we look at one with a relative high mean return but still diversified (the 17th in figure 12). Then we apply to it our qualitative analysis and we select our final composition.

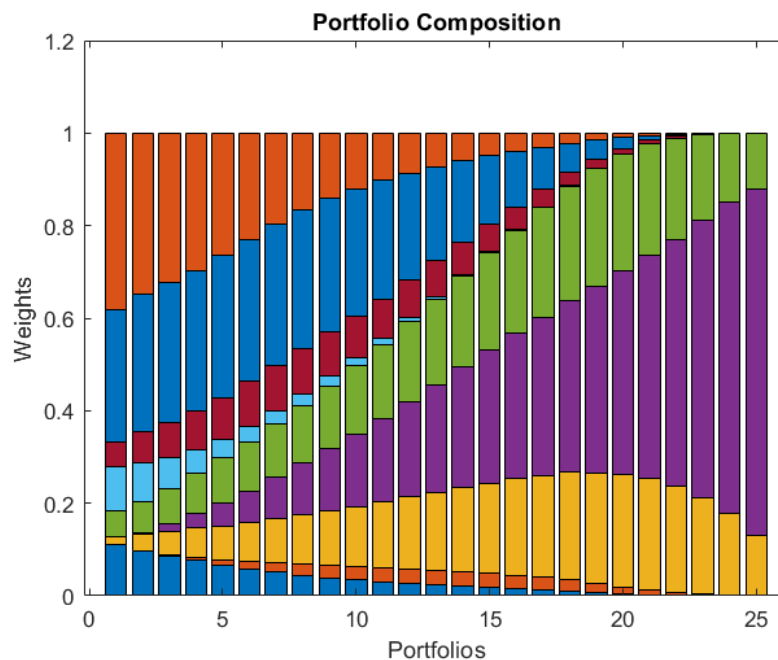


Figure 12: Portfolio Composition

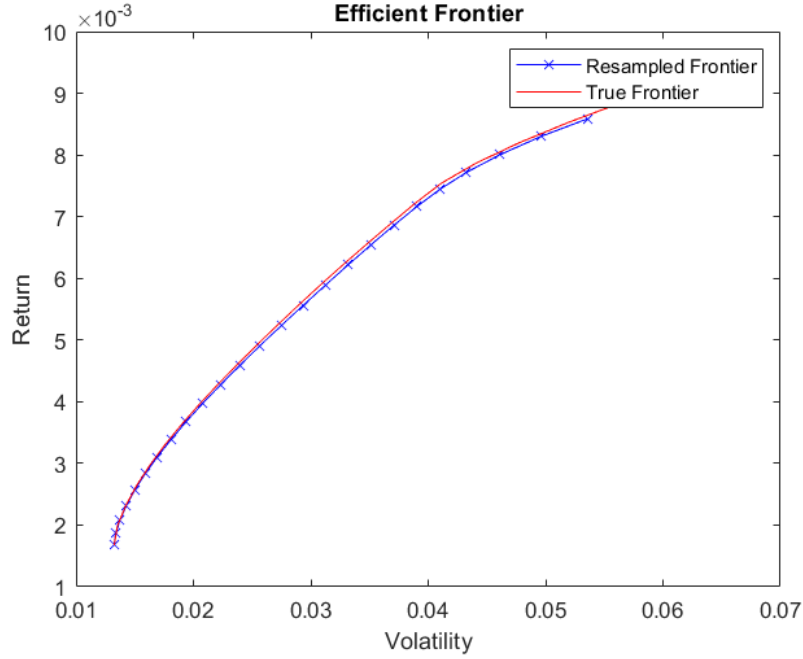


Figure 13: Efficient Frontier

In the table below we collect the numerical results for the 17th portfolio composition on the efficient frontier where in the first line there are the weights related to the only equity part while in the second one they are rescaled to the 65%, their true weight in the portfolio.

AMZN	MSFT	ZM	ENPH	MRNA	BAFWX	MC.PA	6758.T	0P0000ZZBQ	
2.01%	3.15%	26.85%	29.13%	19.66%	0.48%	3.88%	11.04%	3.81%	1
1.31%	2.05%	17.45%	18.93%	12.78%	0.31%	2.55%	7.18%	2.50%	0.65

4.2.1 Amazon.com, Inc (AMZN)

28/10/2020	12/11/2020
5.00%	3.25%

Even if the health emergency of the last months brought the boom of the so-called "stay at home economy" the recent news by Pfizer of the effectiveness of more than the 90% of the anti-Covid vaccine, generated a violent sell off for this kind of stocks. Moreover not only the Chinese authorities are concerned about the explosive growth of internet platforms like **Alibaba**. Also the European Union has announced antitrust charges against **Amazon**, which is accused of abusing of its market power.

For these reasons we decide to decrease our holdings in the company but not completely since we think that the pandemic has only quickened the transition to the digital and so we have reasons to believe that **Amazon** will overcome these events.

4.2.2 Microsoft Corporation (MSFT)

28/10/2020	12/11/2020
4.00%	3.25%

We choose the same weight of **Amazon** also for **Microsoft** for the same reasoning about the development of the tech world despite the vaccine news.

4.2.3 Zoom video communications, Inc (ZM)

28/10/2020	12/11/2020
4.00%	6.50%

If we look at the weights suggested by the numerical implementation of the problem we see a big difference with those we actually selected. The high amount of shares proposed by the algorithm is due to the huge growth the company has undergone under the pandemic; because of the recent news just illustrated about the "stay at home economy", we do not think that these results can be replicated. Since, as we already stated, we opted for a riskier approach, trying to achieve a higher return, given that **Zoom** has shown a higher possibility of big growth rather than **Amazon** and **Microsoft**, its weight in our portfolio is higher.

4.2.4 Sony Corporation (6758.T)

28/10/2020	12/11/2020
6.00%	9.75%

As in the past weeks, we are still waiting for a possible boom of the price of the stock due to the launch of the new console "PS5". Moreover, since we dropped our holdings of **Alibaba**, we increase our positions in **Sony** to balance the exposure to the Asian market.

4.2.5 Enphase Energy, Inc (ENPH)

28/10/2020	12/11/2020
4.00%	13.00%

Joe Biden is the new US president. The plan of the president is achieving 100% clean energy economy and net-zero emissions; its regime is expected to provide an increase in the cleantech stocks from which companies such as **Enphase Energy** will benefit. If in the previous portfolio we opted for an equilibrium between companies listed in S&P 500 and investments in healthcare and green sectors since American presidential elections were still going on, now we think it is a good idea to boost our exposition in the clean energy sector. Moreover our decision is reinforced by the numerical implementation which highlights a good profile for the company in the period considered for the time series.

4.2.6 Moderna, Inc (MRNA)

28/10/2020	12/11/2020
7.00%	13.00%

As already mentioned this week Pfizer announced its anti-Covid vaccine and this even lifted the stock of the rival **Moderna**. **Moderna** and Pfizer use messenger RNA for their vaccines and thus the Pfizer's promising outcomes are good news also for **Moderna**. **Moderna** has finished accumulating data for a first analysis of its Covid-19 vaccine and expects to have an announcement on the vaccine's efficacy by the end of the month. For these reasons we believe that investing a good amount of our money in this company may be a good choice. For what concerns the quantitative analysis, even the numerical implementation selects a considerable part of the portfolio for this stock. In fact, from the very beginning of the virus, governments spare no expense in order to find the pandemic "antidote"; the Covid vaccine business is potentially worth hundreds of billions. For this reason, share values of pharmaceutical companies are exploded in these last months especially the values of the ones leading

the research such as **Moderna**. Following this ratio and the news of these days we decide to buy new stocks of the company.

4.2.7 LVMH Moët Hennessy-Louis Vuitton Société Européenne (MC.PA)

28/10/2020	12/11/2020
6.00%	13.65%

During the pandemic the luxury sector has been heavily hit; nevertheless **LVMH** managed to overcome the crisis and had a strong comeback in the third quarter. With the announcement of Pfizer the fashion industry has bloomed and we think that this trend can keep going on. Moreover in the last weeks the company has found an agreement for the merger with Tiffany & Co. causing a raise in the value of the stock.

However the algorithm does not suggest to put a lot of our financial resources in **LVMH**, probably due to the difference in returns respect to the sectors that were positively affected by the pandemic such as tech and health care. Nevertheless, for the reasons just explained and in order to have a bigger exposure to the European market, we decide to put nearly the 14% of our total assets in the company.

4.3 Funds Composition

4.3.1 General approach

Following our reasoning, we significantly decrease (from 10% to 1.3% in both of them) our exposure to the equity funds **0P0000ZZBQ** and **BAFWX** adopting a riskier approach. This intuition is supported by the numerical analysis which suggests us to not invest much money in funds if we seek a higher return.

4.3.2 American Funds Capital World Bond Fund Class A (CWBFX)

28/10/2020	12/11/2020
40.00%	35.00%

As already stated, the weight for this fund remains considerably high (35%) even after a little decrease, since its weight is related to the one selected for the Bond Index in the benchmark (see section 5).

4.3.3 Blackrock European Dynamic Fund Fd Accumulation (0P0000ZZBQ)

28/10/2020	12/11/2020
10.00%	1.3%

4.3.4 Brown Advisory Sustainable Growth Fund Institutional Shares (BAFWX)

28/10/2020	12/11/2020
10.00%	1.3%

5 Benchmark constraint

For what concerns the classes of our portfolio we keep a division in fixed income and equity. In the previous period we opted for a 40%, 60% division, respectively; as stated before, to increase our mean return we change the classes weights to 35% and 65%. This procedure is allowed provided that the deviation from the benchmark is not too large (for our benchmark the weights remain 40% and 60%). We stress that the benchmark is a declaration of the risks taken by a fund and in this regard, basing

on a sentence of the Italian Court of Cassation, which condemned a fund manager who departed too much from the declared benchmark causing huge losses to the investors, we conclude that moving away from it involves a liability for damage caused by a mismanagement.

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