MATLAB PROJECT

ASSET PRICING AND PORTFOLIO CHOICE

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I. INTRODUCTION

This Project uses the stocks and markets price data up to 2022 that is in the file data2022 in order to conduct analysis by Matlab. In this report, I conduct four main points analysis including:

- Compute 5 optimal portfolios corresponding to 5 target portfolio expected returns. Set the target returns equally spaced between the expected return of the minimum variance portfolio and the maximum feasible expected return (ignore Matlab warnings).
- Compute the corresponding portfolio risk. Plot the efficient frontier and comment on the results.
- Impose constraints (i.e., bounds) on groups of stocks, of my choice. Motivate my choice. Then, following your constraints, compute 10 optimal portfolios, starting with the minimum variance portfolio: compute the optimal weight for each asset, and the corresponding portfolio return and risk. Plot my menu of asset allocations and comment on my results
- Using a market model, compute the alpha and beta for each asset. Comment on the statistical and economic output of your estimation. Finally, derive the expected return of each asset according to the model, and compare it with the actual data.
- Compute the minimum variance portfolio using data up to 2020 and measure its performance in 2021. Compare it against the equally weighted portfolio and comment on the results. Use a similar approach to study portfolio performance during the Covid-19 crisis.

This Project consists of two files, a Matlab code (‘.m file’) and this final report on a PDF document. The Matlab code is used only to conduct analysis and obtain the results. Then I will report and describe all the results, and plots in this report.

II. RESULTS AND DISCUSSION

1. Compute 5 Optimal Portfolios Corresponding To 5 Target Portfolio Expected Returns:

First of all, I will transform the ‘’Data2022’’ excel file into a Matlab data file. According to the data file, We have 14 stocks’ data and 3 market index data from 01/01/2019 to 31/12/2021 including US (Enel, Intesa Sanpaolo, Leonardo, Tim, Jp Morgan Chase&Co, General Electric, Nike ‘B’ and Apple); UK (Bp, Tesco, Barclays) and Germany (Commerzbank, Volkswagen And Adidas).

Variables - stocks

stocks

1x14 cell

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	ENEL	INTESA SA...	LEONARDO	TIM	BP	TESCO	BARCLAYS	COMMERZ...	VOLKSWA...	ADIDAS	JP MORGA...	GENERAL E...	NIKE 'B'	APPLE

Figure 1 Stocks Variables

Variables - ExpRet

ExpRet

1x14 double

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	5.7085e-04	3.9363e-04	8.4068e-05	0.0027	-2.1500e-04	6.3564e-04	6.0608e-04	6.1494e-04	0.0012	6.1206e-04	8.5787e-04	0.0010	0.0012	0.0021
2														

Figure 2 Expected Return For Each Stock

And then I compute the daily return of each stock and the expected return by mean returns. Following, I use the function ‘’Efficientportfolio3’’ to compute 5 optimal portfolios corresponding to 5 target portfolio expected returns. In ‘’Efficientportfolio3’’, the target returns are set equally between the expected return of the minimum variance portfolio and the maximum feasible expected return.

0.1434	*0.0617*	*0.0093*	*0.0030*	*0.0000*
0.0274	*0.0098*	*0.0040*	*0.0019*	*0.0000*
0.0061	*0.0034*	*0.0019*	*0.0011*	*0.0000*
0.0586	*0.1572*	*0.2625*	*0.3752*	*1.0000*
0.0155	*0.0037*	*0.0017*	*0.0009*	*0.0000*
0.4693	*0.3756*	*0.2238*	*0.0189*	*0.0000*
0.0043	*0.0045*	*0.0035*	*0.0023*	*0.0000*
0.0048	*0.0044*	*0.0032*	*0.0020*	*0.0000*
0.0139	*0.0187*	*0.0163*	*0.0081*	*0.0000*
0.0655	*0.0229*	*0.0063*	*0.0026*	*0.0000*
0.0200	*0.0123*	*0.0060*	*0.0030*	*0.0000*
0.0080	*0.0076*	*0.0054*	*0.0032*	*0.0000*
0.0818	*0.0881*	*0.0617*	*0.0171*	*0.0000*
0.0813	*0.2301*	*0.3944*	*0.5606*	*0.0000*

Table 1 5 Portfolio's Weights

As we can see in the Table 1, from minimum variance portfolio to maximum feasible portfolio, the weight of stock TIM and APPLE increases while it decreases in stock TESCO. In the maximum feasible portfolio, we almost only invest in stock TIM. Furthermore, we invest mainly in stock numbers 4, 6, and 14 which have a higher expected return.

Portfolio	1	2	3	4	5
FROReturn	0.00091125	0.00137085	0.00183046	0.00229006	0.00274967
FRORisk	0.00012833	0.00014643	0.00020484	0.00031180	0.00088532

Table 2 Portfolio Returns and Risks

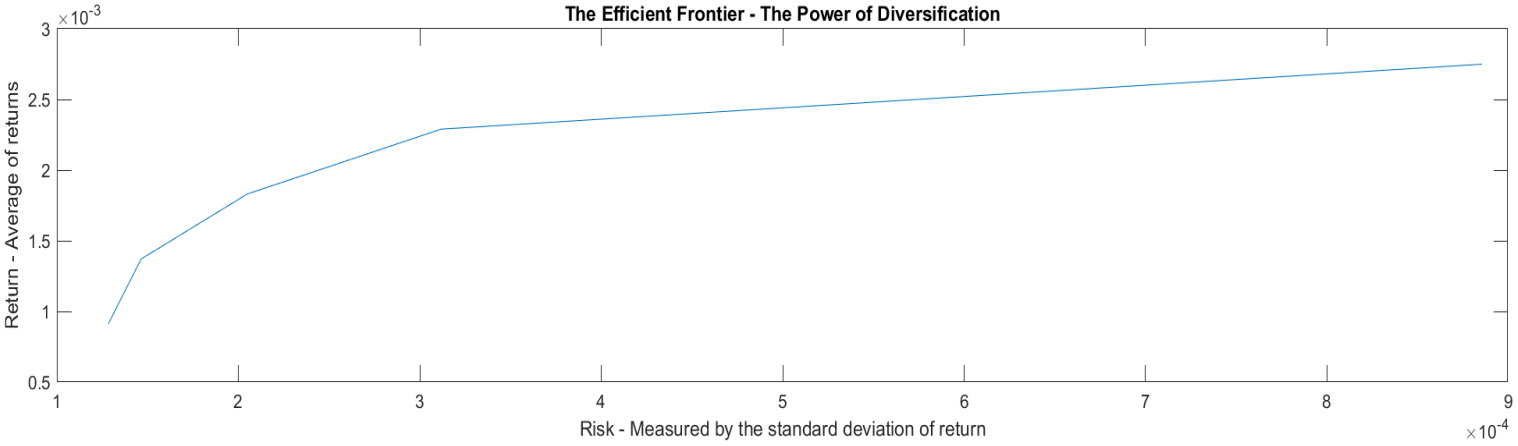


Figure 3 The Efficient Frontier - The Power of Diversification

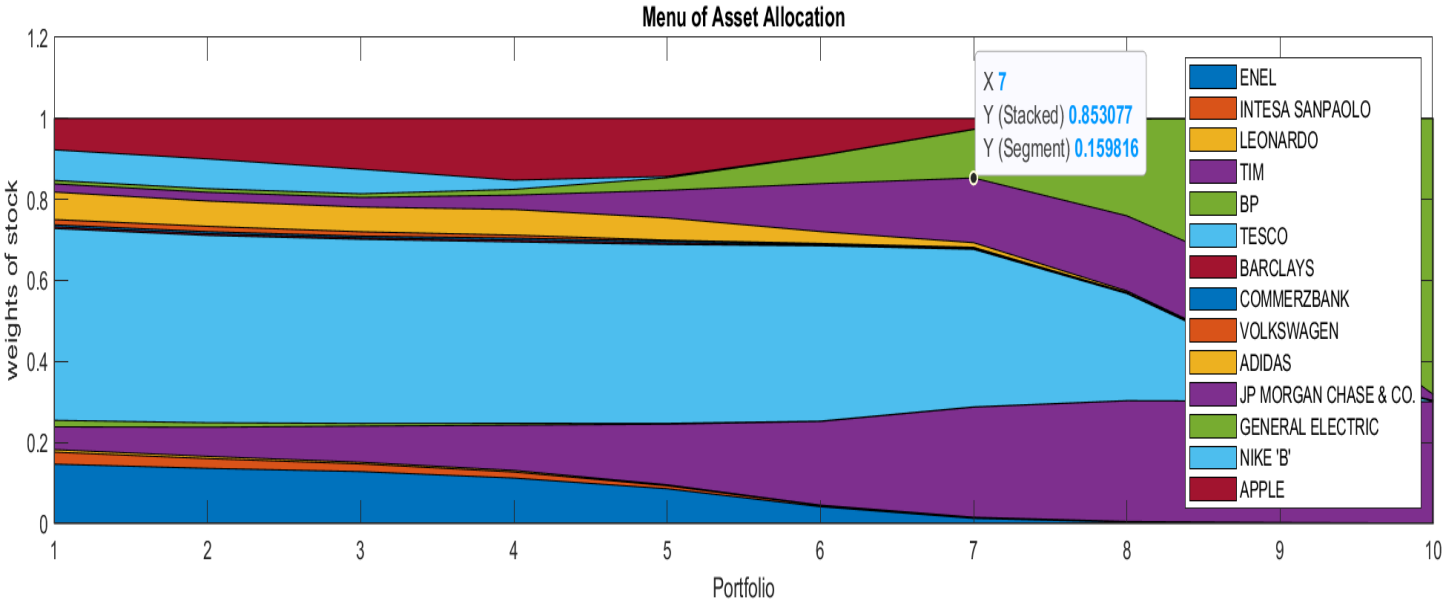
According to the table of Portfolio Returns and Risks and The Efficient Frontier, the safer portfolio (low risk) will deliver the lower return and the higher risk will deliver the higher return. Therefore, diversifying across assets results in reducing total portfolio volatility.

2. Constraints On Groups Of Stocks

In this section, I will choose a group of stocks on my own, which includes stock numbers 4 - TIM, 9 - VOLKSWAGEN, 13 – NIKE “B”, and 14 - APPLE. I choose this group because it consists of stocks in all three different markets and different areas, in addition, they have the highest expected returns compared to others. And in order to diversify my portfolio for reducing total portfolio volatility, I will set an upper bound for this group that is not higher than 30%. For computing 10 optimal portfolios, starting with the minimum variance portfolio following my constraints, I use the function “ EfficientPortfolio5” with 5 arguments.

Portfolio	1	2	3	4	5	6	7	8	9	10
'ENEL'	0.1465	0.1361	0.1281	0.1121	0.0857	0.0413	0.0125	0.0035	0.0017	0.0006
'INTESA SANPAOLO'	0.0296	0.0241	0.0190	0.0150	0.0075	0.0029	0.0020	0.0010	0.0006	0.0003
'LEONARDO'	0.0062	0.0056	0.0041	0.0040	0.0024	0.0011	0.0009	0.0005	0.0003	0.0001
'TIM'	0.0562	0.0718	0.0891	0.1116	0.1495	0.2065	0.2718	0.2980	0.2991	0.2996
'BP'	0.0162	0.0111	0.0067	0.0047	0.0021	0.0008	0.0006	0.0003	0.0002	0.0001
'TESCO'	0.4736	0.4624	0.4545	0.4476	0.4415	0.4328	0.3890	0.2643	0.0889	0.0012
'BARCLAYS'	0.0043	0.0044	0.0038	0.0046	0.0040	0.0025	0.0022	0.0014	0.0009	0.0004
'COMMERZBANK'	0.0049	0.0049	0.0043	0.0051	0.0044	0.0026	0.0022	0.0013	0.0009	0.0005
'VOLKSWAGEN'	0.0129	0.0131	0.0106	0.0073	0.0024	0.0008	0.0006	0.0003	0.0001	0.0001
'ADIDAS'	0.0679	0.0626	0.0610	0.0632	0.0550	0.0293	0.0114	0.0036	0.0018	0.0006
'JP MORGAN CHASE & CO.'	0.0203	0.0215	0.0237	0.0356	0.0680	0.1183	0.1598	0.1855	0.1995	0.0150
'GENERAL ELECTRIC'	0.0085	0.0089	0.0091	0.0141	0.0311	0.0689	0.1197	0.2388	0.4054	0.6812
'NIKE "B"	0.0755	0.0735	0.0608	0.0228	0.0034	0.0010	0.0007	0.0003	0.0002	0.0001
'APPLE'	0.0775	0.0998	0.1252	0.1524	0.1430	0.0911	0.0266	0.0013	0.0005	0.0002

Table 3 The Weights of Group Assets With Constraints



With the constraints on my group of stocks, I have 10 optimal portfolios starting with the minimum variance portfolio, the optimal weight of each asset changes across the portfolio with an upper bound, for example in the minimum variance portfolio, we also invest mainly in stocks TIM and Tesco with the weight of TIM not exceed upper bound. As we can see, the upper bound has affected our portfolio more than without it, especially the effect of weight in portfolio 4 for TIM stock, the portfolios are more diversified now (BP and Jp Morgan and General Electric are in concern). The largest weight of Apple is in portfolios 3, 4 and 5. Tesco has a downward trend from the minimum portfolio, whereas TIM, BP and Jp Morgan have an upward trend.

Portfolio	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
GrpReturn	0.000895	0.000968	0.001041	0.001114	0.001187	0.00126	0.001333	0.001406	0.001479	0.001552
GrpRisk	0.000128	0.000129	0.00013	0.000133	0.00014	0.000157	0.000191	0.000249	0.000359	0.000538

Table 4 Returns and Risks of Group Stocks

As we can see, the optimal portfolio with constraints has increased the diversification of portfolios and reduced portfolio volatility. However, a lower risk delivers a lower return than an initial portfolio without constraints.

3. Using A Market Model, Compute The Alpha And Beta For Each Asset

For using a market model, I compute the market return for 3 markets UK, Germany and the US, then compute alpha and beta by Matlab code.

Stock	Enel	Intesa Sanpaolo	Leonardo	TIM	BP	Tesco	Barclays	Commerzbank	Volkswagen	Adidas	Jp Morgan	General Electric	Nike ‘’B’’	Apple
Alpha (a)	-1.544E-05	-0.0003	-0.0007	0.0024	-0.0005	0.0005	0.0003	-0.0002	0.0005	0.0000	-0.0002	0.0000	0.0002	0.0006
Beta (b)	0.4393	0.5240	0.5777	0.2515	1.5513	0.4868	1.5582	1.2422	1.1100	0.9500	0.7685	0.7703	0.7418	1.1633

Table 5 Alpha and Beta of Stocks

The beta (β) of a stock is a measurement of its volatility of returns relative to the entire market. It is used as a measure of risk and is an integral part of the Capital Asset Pricing Model (CAPM). A company with a higher beta has greater risk and also greater expected returns. According to the result of Alpha and Beta, We can see that stocks BP, Barclays, Commerzbank, Volkswagen and Apple are speculative assets (Beta is greater than 1) that are more volatile than the market, so they are over-investing risky assets, while other stocks (Enel, Intesa Sanpaolo, TIM, Tesco, Adidas, JP Morgan, General Electric and Nike B) are defensive assets (Beta is lower than 1). Whereas stocks with a β that’s lower than 1 are less volatile than the whole market.

Stock	Enel	Intesa Sanpaolo	Leonardo	TIM	BP	Tesco	Barclays	Commerzbank	Volkswagen	Adidas	Jp Morgan	General Electric	Nike ‘’B’’	Apple
E_R (Model)	0.0006	0.0004	0.0001	0.0027	-0.0002	0.0006	0.0006	0.0006	0.0012	0.0006	0.0009	0.0010	0.0012	0.0021
ExpRet (Actual data)	0.0006	0.0004	0.0001	0.0027	-0.0002	0.0006	0.0006	0.0006	0.0012	0.0006	0.0009	0.0010	0.0012	0.0021

Table 6 Compare Model’s Expected Returns and actual Data

As we can see from Table 6, the computed expected returns from our market model are almost the same or insignificantly different from the actual data that we have computed before. Therefore, the model is quite an accurate model.

4. The Minimum Variance Portfolio Using Data Up To 2020

First of all, we need to find the data up to 2020, then compute the expected return and covariance matrix of return for the data up to 2020. And I use the function “portopt” in order to compute the basic minimum variance portfolio, it illustrates the weight of assets in Figure 4 with portfolio return at 0.001and portfolio risk at 0.0126.

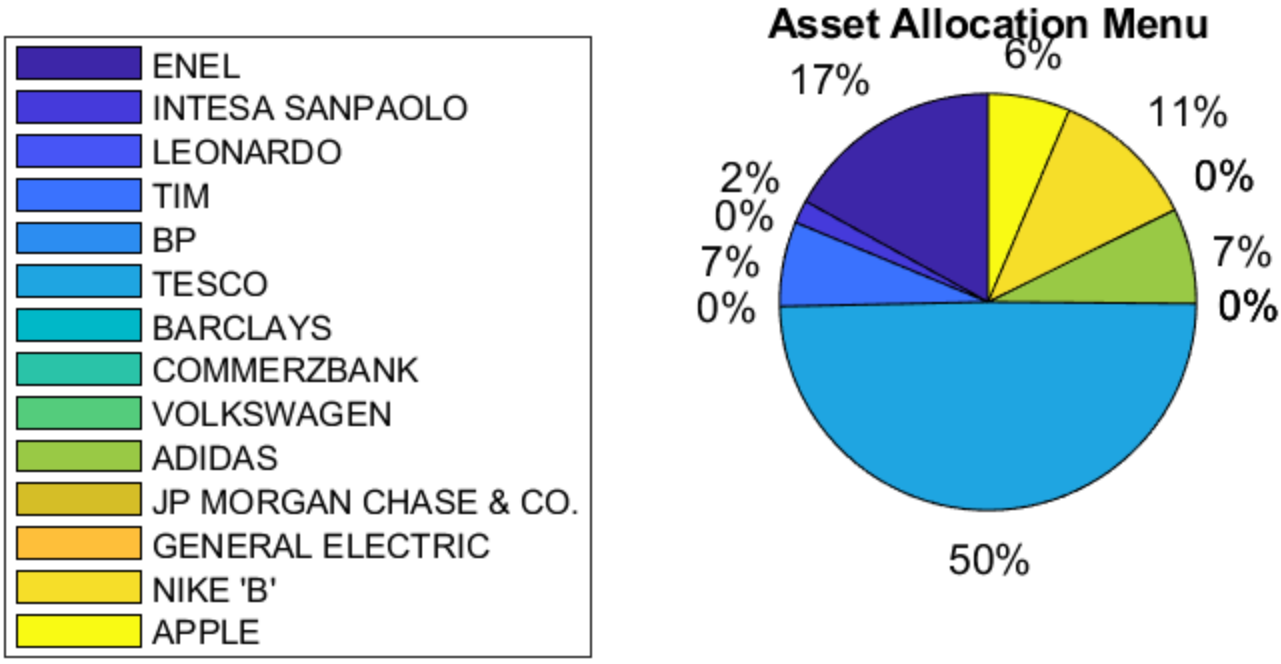


Figure 4 Minimum Variance Portfolio 2020

Then, we use the actual data in 2021 in order to measure 2020 portfolio performance. If we invest in the same minimum variance portfolio in 2020 like Figure 4, and we use the function "portstats" to compute the actual return and risk of the portfolio in Table 7, the minimum variance portfolio has a higher return but lower risk than the actual performance in 2021. Therefore, the minimum variance portfolio in 2020 has bad performance in 2021 than estimated.

	Expected Return	Risk
2020 Portfolio	0.000977748	0.000160143
Actual data 2021	0.000715004	0.00812318

Table 7 Compare Portfolio 2020 and actual data 2021

Now, I compare the minimum variance portfolio in 2020 with the equal weight portfolio in 2020 in Table 8. As we can see that the MV portfolio delivers a higher return with lower risk than the equal-weight portfolio. Therefore, we should invest in the MV portfolio.

	Expected Return	Risk
2020 MV Portfolio	0.000977748	0.000160143
2020 Equal-weight Portfolio	0.000868661	0.017357798

Table 8 Compare MV portfolio and equal-weight portfolio in 2020