

Module leader- Dr Jonathan Iworiso, date-jan30/2023.

MA7008 – Financial Mathematics Coursework 2022/23

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(i) Download the historical prices of any five stocks previously selected in your portfolio. The historical prices should go back a sufficient period in time from the date that you obtain the data in order to yield positive average returns. Give a brief description of each company and the type of business they are in.

Calculate the expected return and the volatility for each company as well as the correlations between the asset returns.

| | | barclays | | | | | |
|-------------|--------------|-----------------|------------------------|-----------------|-------------------|--------------------|--|
| Date | Close | returns | expected return | VARIANCE | volatility | correlation | |
| 26/01/2022 | 11.04 | | | | | | |
| 27/01/2022 | 11.05 | -0.0009054 | 0.000751085 | 0.02591068 | 0.02591068 | -0.043013 | |
| 28/01/2022 | 10.81 | 0.0219588 | | | | | |
| 31/01/2022 | 10.89 | -0.0073733 | | | | | |
| 02/01/2022 | 11.13 | -0.0217992 | | | | | |
| 02/02/2022 | 11.31 | -0.0160431 | | | | | |
| 02/03/2022 | 11.26 | 0.00443067 | | | | | |
| 02/04/2022 | 11.19 | 0.0062361 | | | | | |
| 02/07/2022 | 11.34 | -0.0133158 | | | | | |
| 02/08/2022 | 11.45 | -0.0096534 | | | | | |
| 02/09/2022 | 11.42 | 0.00262353 | | | | | |
| 02/10/2022 | 11.4 | 0.00175285 | | | | | |
| 02/11/2022 | 11.07 | 0.02937461 | | | | | |
| 14/02/2022 | 10.68 | 0.03586591 | | | | | |
| 15/02/2022 | 10.87 | -0.0176339 | | | | | |
| 16/02/2022 | 10.78 | 0.00831414 | | | | | |
| 17/02/2022 | 10.54 | 0.02251502 | | | | | |
| 18/02/2022 | 10.49 | 0.00475512 | | | | | |
| 22/02/2022 | 10.47 | 0.0019084 | | | | | |
| 23/02/2022 | 10.74 | -0.0254611 | | | | | |
| 24/02/2022 | 9.94 | 0.07740807 | | | | | |
| 25/02/2022 | 10.35 | -0.0404195 | | | | | |
| 28/02/2022 | 9.9 | 0.04445176 | | | | | |
| 03/01/2022 | 9.31 | 0.06144567 | | | | | |
| 03/02/2022 | 9.63 | -0.0337941 | | | | | |
| 03/03/2022 | 9.13 | 0.05331753 | | | | | |
| 03/04/2022 | 8.38 | 0.08571778 | | | | | |
| 03/07/2022 | 7.94 | 0.05393464 | | | | | |
| 03/08/2022 | 8.28 | -0.0419297 | | | | | |
| 03/09/2022 | 8.66 | -0.0448718 | | | | | |

- Barclays is one the best banking companies and is a British multinational universal bank with a revenue 21.94 billion GBP. They operate over 50 countries, has about 156,000 employee and protects investment of 48 million clients globally.

| | HSBC | | | | | |
|-------------|--------------|---------------|----------------------|-------------------|--------------------|--|
| Date | Close | return | exepected ret | volatility | correlation | |
| 26/01/2022 | 35.060001 | | | | | |
| 27/01/2022 | 35.75 | 0.01948936 | 0.00022407 | 0.02084065 | 0.1249285 | |
| 28/01/2022 | 35.450001 | -0.008427 | | | | |
| 31/01/2022 | 35.57 | 0.00337931 | | | | |
| 01/02/2022 | 36.880001 | 0.03616684 | | | | |
| 02/02/2022 | 37.23 | 0.00944546 | | | | |
| 03/02/2022 | 36.939999 | -0.0078199 | | | | |
| 04/02/2022 | 37.099998 | 0.00432197 | | | | |
| 07/02/2022 | 37.549999 | 0.01205644 | | | | |
| 08/02/2022 | 38.25 | 0.01847021 | | | | |
| 09/02/2022 | 37.799999 | -0.0118345 | | | | |
| 10/02/2022 | 37.860001 | 0.0015861 | | | | |
| 11/02/2022 | 37.810001 | -0.0013215 | | | | |
| 14/02/2022 | 37.529999 | -0.0074331 | | | | |
| 15/02/2022 | 37.419998 | -0.0029353 | | | | |
| 16/02/2022 | 37.16 | -0.0069724 | | | | |
| 17/02/2022 | 36.5 | -0.0179207 | | | | |
| 18/02/2022 | 36.810001 | 0.00845731 | | | | |
| 22/02/2022 | 37.09 | 0.00757782 | | | | |
| 23/02/2022 | 36.950001 | -0.0037817 | | | | |
| 24/02/2022 | 34.889999 | -0.0573654 | | | | |
| 25/02/2022 | 36.27 | 0.03879073 | | | | |
| 28/02/2022 | 34.540001 | -0.0488729 | | | | |
| 01/03/2022 | 33.16 | -0.0407738 | | | | |
| 02/03/2022 | 34.049999 | 0.02648567 | | | | |
| 03/03/2022 | 33.25 | -0.0237752 | | | | |
| 04/03/2022 | 31.23 | -0.0626756 | | | | |
| 07/03/2022 | 30.59 | -0.020706 | | | | |
| 08/03/2022 | 31.370001 | 0.0251789 | | | | |
| 09/03/2022 | 32.18 | 0.02549309 | | | | |
| 10/03/2022 | 31.37 | 0.028686 | | | | |

- HSBC is also a famous bank in the United Kingdom and a British multinational bank who serve about 40 million clients worldwide with about 219,697 employees.

| | | SHELL | | | |
|-------------|--------------|----------------|---------------------|-------------------|--------------------|
| Date | Close | returns | expected ret | volatility | correlation |
| 26/01/2022 | 50.91 | | | | |
| 27/01/2022 | 51.110001 | 0.00392082 | 0.00051049 | 0.02126778 | 0.18221441 |
| 28/01/2022 | 51.040001 | -0.0013705 | | | |
| 31/01/2022 | 51.400002 | 0.00702855 | | | |
| 01/02/2022 | 52.68 | 0.02459767 | | | |
| 02/02/2022 | 53.25 | 0.01076193 | | | |
| 03/02/2022 | 53.91 | 0.01231819 | | | |
| 04/02/2022 | 55.099998 | 0.02183369 | | | |
| 07/02/2022 | 55.709999 | 0.01100997 | | | |
| 08/02/2022 | 54.650002 | -0.0192104 | | | |
| 09/02/2022 | 54.759998 | 0.00201071 | | | |
| 10/02/2022 | 54.52 | -0.0043924 | | | |
| 11/02/2022 | 55.209999 | 0.01257647 | | | |
| 14/02/2022 | 54.380001 | -0.0151476 | | | |
| 15/02/2022 | 53.470001 | -0.0168757 | | | |
| 16/02/2022 | 54.040001 | 0.01060376 | | | |
| 17/02/2022 | 53.630001 | -0.0076159 | | | |
| 18/02/2022 | 53.240002 | -0.0072986 | | | |
| 22/02/2022 | 52.669998 | -0.010764 | | | |
| 23/02/2022 | 52.630001 | -0.0007597 | | | |
| 24/02/2022 | 51.59 | -0.0199585 | | | |
| 25/02/2022 | 54.209999 | 0.04953752 | | | |
| 28/02/2022 | 52.389999 | -0.0341497 | | | |
| 01/03/2022 | 51.77 | -0.0119049 | | | |
| 02/03/2022 | 54.619999 | 0.05358927 | | | |
| 03/03/2022 | 51.349998 | -0.0617352 | | | |
| 04/03/2022 | 49.389999 | -0.0389169 | | | |
| 07/03/2022 | 51.560001 | 0.04299824 | | | |
| 08/03/2022 | 52.939999 | 0.02641298 | | | |
| 09/03/2022 | 51.709999 | -0.023508 | | | |
| 10/03/2022 | 51.680000 | 0.0003960 | | | |

- Shell plc is a British multinational oil and gas company who has headquartered in London. It has 82,000 employees.

| | | Unilever | | | |
|-------------|--------------|-----------------|---------------------|-------------------|--------------------|
| Date | Close | returns | expected ret | volatility | correlation |
| 26/01/2022 | 51.310001 | | | | |
| 27/01/2022 | 51.200001 | -0.0021461 | -6.44E-05 | 0.01504692 | 0.12758061 |
| 28/01/2022 | 51.299999 | 0.00195118 | | | |
| 31/01/2022 | 51.389999 | 0.00175285 | | | |
| 01/02/2022 | 51.130001 | -0.0050722 | | | |
| 02/02/2022 | 51.200001 | 0.00136812 | | | |
| 03/02/2022 | 51.779999 | 0.0112644 | | | |
| 04/02/2022 | 51.400002 | -0.0073657 | | | |
| 07/02/2022 | 52.25 | 0.01640168 | | | |
| 08/02/2022 | 52.299999 | 0.00095646 | | | |
| 09/02/2022 | 52.139999 | -0.003064 | | | |
| 10/02/2022 | 51.220001 | -0.0178023 | | | |
| 11/02/2022 | 52.73 | 0.02905445 | | | |
| 14/02/2022 | 51.599998 | -0.0216629 | | | |
| 15/02/2022 | 51.490002 | -0.002134 | | | |
| 16/02/2022 | 51.880001 | 0.00754573 | | | |
| 17/02/2022 | 51.689999 | -0.0036691 | | | |
| 18/02/2022 | 52.299999 | 0.01173203 | | | |
| 22/02/2022 | 51.349998 | -0.0183315 | | | |
| 23/02/2022 | 51.599998 | 0.00485674 | | | |
| 24/02/2022 | 49.060001 | -0.0504776 | | | |
| 25/02/2022 | 50.549999 | 0.02991887 | | | |
| 28/02/2022 | 50.27 | -0.0055544 | | | |
| 01/03/2022 | 48.740002 | -0.0309084 | | | |
| 02/03/2022 | 48.669998 | -0.0014373 | | | |
| 03/03/2022 | 47.700001 | -0.0201314 | | | |
| 04/03/2022 | 45.68 | -0.0432709 | | | |
| 07/03/2022 | 43.880001 | -0.0402019 | | | |
| 08/03/2022 | 43.709999 | -0.0038818 | | | |
| 09/03/2022 | 45.419998 | 0.03837561 | | | |

- Unilever plc is a British multinational consumer goods company headquartered in London. It has a revenue of 52.44 billion euro and with 148,00 employees and over 400 brands in 190 countries.

| | | Vodafone | | | | |
|------------|-----------|------------|--------------|------------|-------------|--|
| Date | Close | return | expected ret | volatility | correlation | |
| 26/01/2022 | 16.73 | | | | | |
| 27/01/2022 | 16.799999 | 0.00417531 | -0.0014925 | 0.01918021 | 0.06099966 | |
| 28/01/2022 | 17.77 | 0.05613282 | | | | |
| 31/01/2022 | 17.51 | -0.0147395 | | | | |
| 01/02/2022 | 17.27 | -0.0138013 | | | | |
| 02/02/2022 | 17.879999 | 0.03471182 | | | | |
| 03/02/2022 | 18.18 | 0.01663938 | | | | |
| 04/02/2022 | 18.200001 | 0.00109956 | | | | |
| 07/02/2022 | 18.459999 | 0.01418453 | | | | |
| 08/02/2022 | 18.74 | 0.0150541 | | | | |
| 09/02/2022 | 18.92 | 0.00955929 | | | | |
| 10/02/2022 | 18.639999 | -0.0149098 | | | | |
| 11/02/2022 | 18.610001 | -0.0016106 | | | | |
| 14/02/2022 | 18.389999 | -0.0118921 | | | | |
| 15/02/2022 | 18.74 | 0.01885329 | | | | |
| 16/02/2022 | 18.870001 | 0.00691314 | | | | |
| 17/02/2022 | 18.690001 | -0.0095847 | | | | |
| 18/02/2022 | 18.629999 | -0.0032155 | | | | |
| 22/02/2022 | 18.540001 | -0.0048425 | | | | |
| 23/02/2022 | 18.32 | -0.0119373 | | | | |
| 24/02/2022 | 17.67 | -0.0361251 | | | | |
| 25/02/2022 | 18.01 | 0.01905887 | | | | |
| 28/02/2022 | 17.700001 | -0.0173625 | | | | |
| 01/03/2022 | 17.33 | -0.0211256 | | | | |
| 02/03/2022 | 17.57 | 0.0137538 | | | | |
| 03/03/2022 | 17.139999 | -0.024778 | | | | |
| 04/03/2022 | 16.4 | -0.0441335 | | | | |
| 07/03/2022 | 15.79 | -0.0379045 | | | | |
| 08/03/2022 | 15.59 | -0.0127471 | | | | |
| 09/03/2022 | 16.040001 | 0.02845598 | | | | |

- Vodafone is a British multinational telecommunications company which has headquarters in Berkshire, United Kingdom. It has 94,724 employees with a revenue of 45.58 billion euro.
- I have used the data from yahoo finance and have calculated the volatility, expected return and correlation of each company as seen above. I have used one year worth of data of all 5 companies.

(ii) Use an appropriate Solver function to determine the portfolio risk and the percentage of investment in each asset in your portfolio for a target return of your choice.

Repeat this process for different portfolio target returns and hence, draw the *efficient frontier* curve.

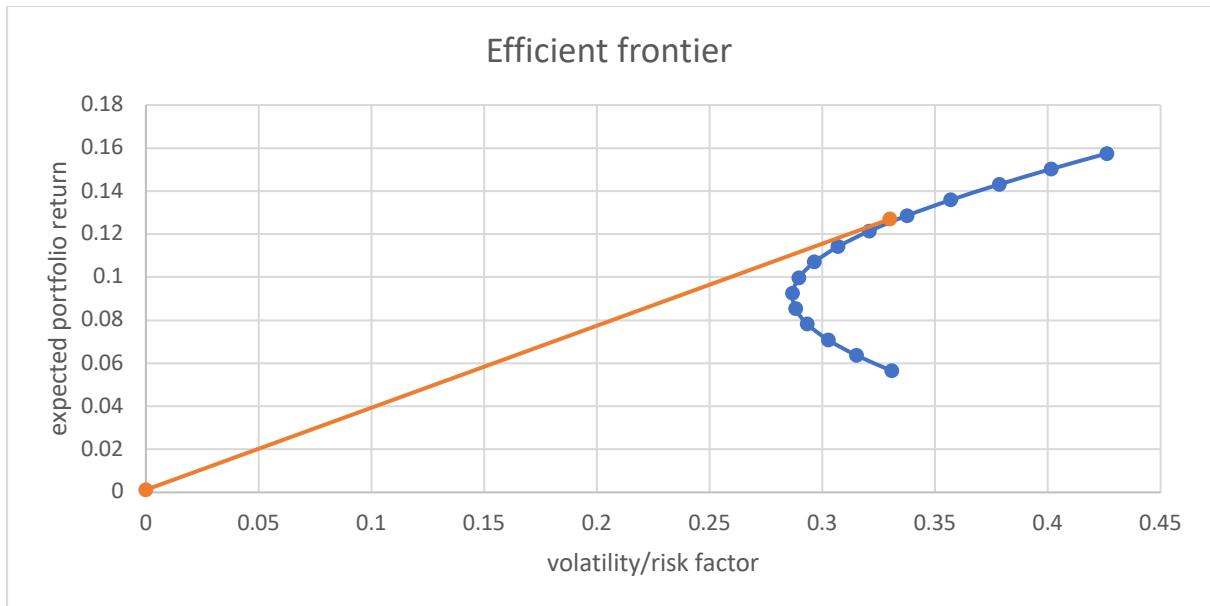
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| Date | daily share prices for 5 assets/stock | | | | | Daily Return | | | | |
|------------|---------------------------------------|-----------|-----------|-----------|-----------|--------------|-------------|------------|------------|------------|
| | barclays | HSBC | SHELL | Unilever | Vodafone | barclays | HSBC | SHELL | Unilever | Vodafone |
| 26/01/2022 | 11.04 | 35.060001 | 50.91 | 51.310001 | 16.73 | 0.0009058 | 0.01968052 | 0.00392852 | -0.0021438 | 0.00418404 |
| 27/01/2022 | 11.05 | 35.75 | 51.110001 | 51.200001 | 16.799999 | -0.0217195 | -0.0083916 | -0.0013696 | 0.00195309 | 0.05773816 |
| 28/01/2022 | 10.81 | 35.450001 | 51.040001 | 51.299999 | 17.77 | 0.00740056 | 0.00338502 | 0.00705331 | 0.00175439 | -0.0146314 |
| 31/01/2022 | 10.89 | 35.57 | 51.400002 | 51.389999 | 17.51 | 0.02203857 | 0.03682882 | 0.02490268 | -0.0050593 | -0.0137065 |
| 01/02/2022 | 11.13 | 36.880001 | 52.68 | 51.130001 | 17.27 | 0.01617251 | 0.00949021 | 0.01082005 | 0.00136906 | 0.03532131 |
| 02/02/2022 | 11.31 | 37.23 | 53.25 | 51.200001 | 17.879999 | -0.0044209 | -0.0077894 | 0.01239437 | 0.01132809 | 0.01677858 |
| 03/02/2022 | 11.26 | 36.939999 | 53.91 | 51.779999 | 18.18 | -0.0062167 | 0.00433132 | 0.02207379 | -0.0073387 | 0.00110017 |
| 04/02/2022 | 11.19 | 37.099998 | 55.099998 | 51.400002 | 18.200001 | 0.01340483 | 0.01212941 | 0.0110708 | 0.01653693 | 0.0142856 |
| 07/02/2022 | 11.34 | 37.549999 | 55.709999 | 52.25 | 18.459999 | 0.00970018 | 0.01864184 | -0.0190271 | 0.00095692 | 0.01516799 |
| 08/02/2022 | 11.45 | 38.25 | 54.650002 | 52.299999 | 18.74 | -0.0026201 | -0.0117647 | 0.00201274 | -0.0030593 | 0.00960512 |
| 09/02/2022 | 11.42 | 37.799999 | 54.759998 | 52.139999 | 18.92 | -0.0017513 | 0.00158735 | -0.0043827 | -0.0176448 | -0.0147992 |
| 10/02/2022 | 11.4 | 37.860001 | 54.52 | 51.220001 | 18.639999 | -0.0289474 | -0.0013207 | 0.01265589 | 0.02948065 | -0.0016093 |
| 11/02/2022 | 11.07 | 37.810001 | 55.209999 | 52.73 | 18.610001 | -0.0352304 | -0.0074055 | -0.0150335 | -0.02143 | -0.0118217 |
| 14/02/2022 | 10.68 | 37.529999 | 54.380001 | 51.599998 | 18.389999 | 0.01779026 | -0.002931 | -0.0167341 | -0.0021317 | 0.01903214 |
| 15/02/2022 | 10.87 | 37.419998 | 53.470001 | 51.490002 | 18.74 | -0.0082797 | -0.0069481 | 0.01066018 | 0.00757427 | 0.00693709 |
| 16/02/2022 | 10.78 | 37.16 | 54.040001 | 51.880001 | 18.870001 | -0.0222635 | -0.017761 | -0.007587 | -0.0036623 | -0.009539 |
| 17/02/2022 | 10.54 | 36.5 | 53.630001 | 51.689999 | 18.690001 | -0.0047438 | 0.00849318 | -0.007272 | 0.01180112 | -0.0032104 |
| 18/02/2022 | 10.49 | 36.810001 | 53.240002 | 52.299999 | 18.629999 | -0.0019066 | 0.0076066 | -0.0107063 | -0.0181645 | -0.0048308 |
| 22/02/2022 | 10.47 | 37.09 | 52.669998 | 51.349998 | 18.540001 | 0.02578797 | -0.0037746 | -0.0007594 | 0.00486855 | -0.018663 |
| 23/02/2022 | 10.74 | 36.950001 | 52.630001 | 51.599998 | 18.32 | -0.0744879 | -0.00557511 | -0.0197606 | -0.0492247 | -0.0354803 |
| 24/02/2022 | 9.94 | 34.889999 | 51.59 | 49.060001 | 17.67 | 0.04124748 | 0.03955291 | 0.05078502 | 0.03037093 | 0.01924165 |
| 25/02/2022 | 10.35 | 36.27 | 54.209999 | 50.549999 | 18.01 | -0.0434783 | -0.0476978 | -0.0335731 | -0.0055391 | -0.0172126 |
| 28/02/2022 | 9.9 | 34.540001 | 52.389999 | 50.27 | 17.700001 | -0.059596 | -0.0399537 | -0.0118343 | -0.0304356 | -0.020904 |
| 01/03/2022 | 9.31 | 33.16 | 51.77 | 48.740002 | 17.33 | 0.03437164 | 0.02683954 | 0.05505117 | -0.0014363 | 0.01384882 |
| 02/03/2022 | 9.63 | 34.049999 | 54.619999 | 48.669998 | 17.57 | -0.0519211 | -0.0234948 | -0.0598682 | -0.0199301 | -0.0244736 |
| 03/03/2022 | 9.13 | 33.25 | 51.349998 | 47.700001 | 17.139999 | -0.0821468 | -0.0607519 | -0.0381694 | -0.042348 | -0.0431738 |
| 04/03/2022 | 8.38 | 31.23 | 49.389999 | 45.68 | 16.4 | -0.052506 | -0.0204931 | 0.04393606 | -0.0394045 | -0.0371951 |
| 07/03/2022 | 7.94 | 30.59 | 51.560001 | 43.880001 | 15.79 | 0.04282116 | 0.02549856 | 0.02676489 | -0.0038742 | -0.0126662 |
| 08/03/2022 | 8.28 | 31.370001 | 52.939999 | 43.709999 | 15.59 | 0.04589372 | 0.02582082 | -0.0232339 | 0.03912146 | 0.02886472 |
| 09/03/2022 | 8.66 | 32.18 | 51.709999 | 45.419998 | 16.040001 | -0.0242494 | -0.0282784 | -0.0003868 | -0.0235579 | -0.0155861 |
| 10/03/2022 | 8.45 | 31.27 | 51.689999 | 44.349998 | 15.79 | -0.0035503 | -0.0047969 | -0.014703 | -0.0090191 | -0.0063331 |
| 11/03/2022 | 8.42 | 31.120001 | 50.93 | 43.950001 | 15.69 | 0.05344418 | 0.02281488 | -0.0190458 | 0.00910118 | 0.01657106 |

- The Daily share and daily return for 5 assets.

| Mean and SD of the returns(Annualized) | | Varaince-Covariance matrix | | | | | | | | | |
|--|------------|-----------------------------------|------------|--------------|-------------|--------------|-------------------------------------|--------------|-------------|--------------|-------------|
| assets | weights | barclays | HSBC | SHELL | Unilever | Vodafone | assets | weights | barclays | HSBC | SHELL |
| barclays | 0.1052627 | 0.40933697 | barclays | 0.166886531 | 0.10133448 | 0.06332762 | 0.04602856 | 0.072679534 | | | |
| HSBC | 0.11103026 | 0.331376 | HSBC | 0.101334478 | 0.10937081 | 0.05261417 | 0.03428672 | 0.052776403 | | | |
| SHELL | 0.18532782 | 0.33661937 | SHELL | 0.063327617 | 0.05261417 | 0.11285935 | 0.01677175 | 0.033327246 | | | |
| Unilever | 0.0122859 | 0.24034732 | Unilever | 0.046028564 | 0.03428672 | 0.01677175 | 0.05753576 | 0.02896542 | | | |
| Vodafone | -0.3297808 | 0.30353263 | Vodafone | 0.072679534 | 0.0527764 | 0.03332725 | 0.02896542 | 0.091763531 | | | |
| risk_free | | 0.015 | | | | | | | | | |
| equally weighted portfolio | | equally weighted portfolio | | | | | optimized weighted portfolio | | | | |
| assets | weights | assets | weights | assets | weights | assets | weights | assets | weights | assets | weights |
| barclays | 0 | barclays | 0.2 | barclays | 0 | barclays | 0 | barclays | 0 | barclays | 0 |
| HSBC | 0.1214201 | HSBC | 0.2 | HSBC | 0.121419133 | HSBC | 0.974481835 | HSBC | 0.121420096 | HSBC | 0.121420096 |
| SHELL | 0.8785799 | SHELL | 0.2 | SHELL | 0.878580867 | SHELL | 0.025518165 | SHELL | 0.878579904 | SHELL | 0.878579904 |
| Unilever | 0 | Unilever | 0.2 | Unilever | 0 | Unilever | 0 | Unilever | 0 | Unilever | 0 |
| Vodafone | 0 | Vodafone | 0.2 | Vodafone | 0 | Vodafone | 0 | Vodafone | 0 | Vodafone | 0 |
| sum | 1 | sum | 1 | sum | 1 | sum | 1 | sum | 1 | sum | 1 |
| expected return | 0.1763066 | expected return | -0.0252799 | expected ret | 0.176306673 | expected ret | 0.112926194 | expected ret | 0.176306602 | expected ret | 0.176306602 |
| std dev | 0.31615556 | std dev | 0.2484061 | std dev | 0.316155704 | std dev | 0.326420509 | std dev | 0.316155564 | std dev | 0.316155564 |
| sharpe ratio | 0.51021276 | sharpe ratio | -0.1621535 | sharpe ratio | 0.510212756 | sharpe ratio | 0.300000127 | sharpe ratio | 0.510212756 | sharpe ratio | 0.510212756 |

- 4 different portfolio target returns with one being the original called the eaully weighted portfolio.

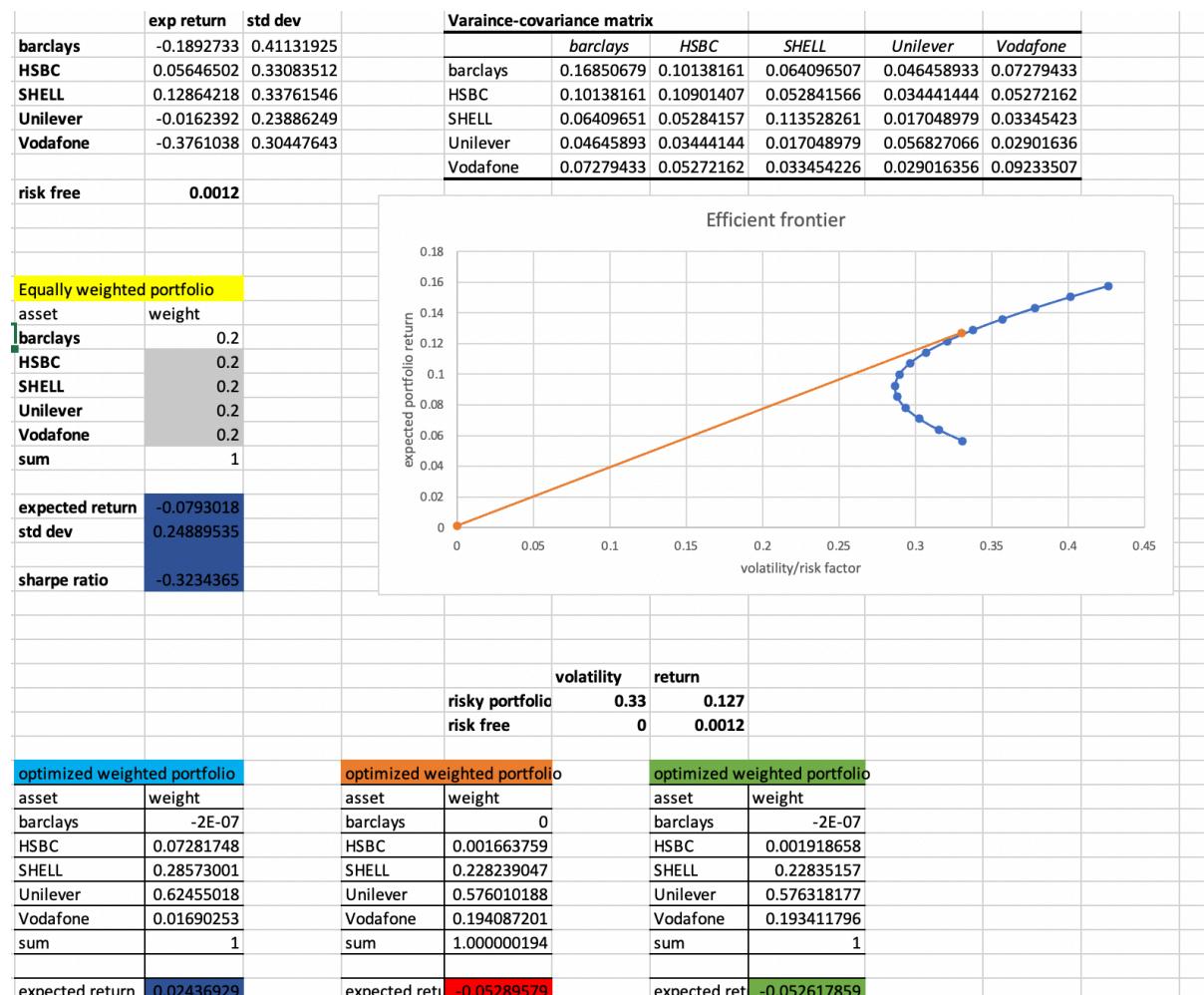


- Above is The EFC curve.

(iii) Calculate the Sharpe ratios for a range of expected portfolio returns and volatilities that you calculated in parts (ii), and by using a risk-free investment guaranteeing a return of 1.5%, determine the equation of the Capital Market Line. Discuss the economic significance of the Capital market Line.

| | daily share prices for 5 assets/stock | | | | Daily return | | | | | | | | |
|------------|---------------------------------------|-----------|-----------|-----------|--------------|-------------|-------------|------------|------------|-------------|------------|---------------|------------|
| Date | barclays | HSBC | SHELL | Unilever | Vodafone | barclays | HSBC | SHELL | Unilever | Vodafone | barclays | exp return | std dev |
| 26/01/2022 | 11.04 | 35.060001 | 50.91 | 51.310001 | 16.73 | 0.00090539 | 0.01948936 | 0.00392082 | -0.0021461 | 0.00417531 | barclays | -0.1892733 | 0.41131925 |
| 27/01/2022 | 11.05 | 35.75 | 51.110001 | 51.200001 | 16.799999 | -0.0219588 | -0.008427 | -0.0013705 | 0.00195118 | 0.05613282 | HSBC | 0.05646502 | 0.33083512 |
| 28/01/2022 | 10.81 | 35.450001 | 51.040001 | 51.299999 | 17.77 | 0.00737331 | 0.0037393 | 0.00702855 | 0.00175285 | -0.0147395 | SHELL | 0.12864218 | 0.33761546 |
| 31/01/2022 | 10.89 | 35.57 | 51.400002 | 51.389999 | 17.51 | 0.02179923 | 0.03616684 | 0.02459767 | -0.0057022 | -0.0138013 | Unilever | -0.0162392 | 0.23886249 |
| 01/02/2022 | 11.13 | 36.880001 | 52.68 | 51.130001 | 17.27 | 0.01604312 | 0.00944546 | 0.01076193 | 0.00136812 | 0.03471182 | Vodafone | -0.3761038 | 0.30447643 |
| 02/02/2022 | 11.31 | 37.23 | 53.25 | 51.200001 | 17.879999 | -0.0044307 | -0.0078199 | 0.01231818 | 0.0112644 | 0.01663937 | risk free | 0.0012 | |
| 03/02/2022 | 11.26 | 36.939999 | 53.91 | 51.779999 | 18.18 | -0.0062361 | 0.00432197 | 0.02183369 | -0.0073657 | 0.00109956 | | | |
| 04/02/2022 | 11.19 | 37.099999 | 55.099998 | 51.400002 | 18.200001 | 0.01331578 | 0.01205644 | 0.01100997 | 0.01640168 | 0.01418453 | | | |
| 07/02/2022 | 11.34 | 37.549999 | 55.709999 | 52.25 | 18.459999 | 0.009655343 | 0.01847021 | -0.0192104 | 0.00095646 | 0.0150541 | | | |
| 08/02/2022 | 11.45 | 38.25 | 54.650002 | 52.299999 | 18.74 | -0.0026235 | -0.0118345 | 0.00201071 | -0.003064 | 0.00955929 | | | |
| 09/02/2022 | 11.42 | 37.799999 | 54.759998 | 52.139999 | 18.92 | -0.0017528 | 0.0015861 | -0.0043924 | -0.0178023 | -0.0149098 | | | |
| 10/02/2022 | 11.4 | 37.860001 | 54.52 | 51.220001 | 18.639999 | -0.0293746 | -0.0013215 | 0.01257647 | 0.02905445 | -0.0016106 | | | |
| 11/02/2022 | 11.07 | 37.810001 | 55.209999 | 52.73 | 18.610001 | -0.0358659 | -0.0074331 | -0.0151476 | -0.0216629 | -0.0118921 | | | |
| 14/02/2022 | 10.68 | 37.529999 | 54.380001 | 51.599998 | 18.389999 | 0.01763837 | 0.01205644 | -0.0029353 | -0.0168757 | -0.002134 | 0.01885329 | | |
| 15/02/2022 | 10.87 | 37.419998 | 53.470001 | 51.490002 | 18.74 | -0.0083141 | -0.0069724 | 0.01060376 | 0.00754573 | 0.006913134 | | | |
| 16/02/2022 | 10.78 | 37.16 | 54.040001 | 51.880001 | 18.870001 | -0.022515 | -0.0179207 | -0.0076159 | -0.0036691 | 0.0095847 | | | |
| 17/02/2022 | 10.54 | 36.5 | 53.630001 | 51.689999 | 18.690001 | -0.0047551 | 0.00845731 | -0.0072986 | 0.01173203 | 0.0032155 | | | |
| 18/02/2022 | 10.49 | 36.810001 | 53.240002 | 52.299999 | 18.629999 | -0.0019084 | 0.00757782 | -0.010764 | -0.0183315 | -0.0048425 | | | |
| 22/02/2022 | 10.47 | 37.09 | 52.669998 | 51.349998 | 18.540001 | 0.02546106 | -0.0037817 | -0.0007597 | 0.00485674 | -0.0119373 | | | |
| 23/02/2022 | 10.74 | 36.950001 | 52.630001 | 51.599998 | 18.32 | -0.0774081 | -0.0573654 | -0.0199585 | -0.0504776 | 0.0361251 | | | |
| 24/02/2022 | 9.94 | 34.889999 | 51.59 | 49.060001 | 17.67 | 0.0404195 | 0.03879073 | 0.04953752 | 0.02991887 | 0.01905887 | | | |
| 25/02/2022 | 10.35 | 36.27 | 54.209999 | 50.549999 | 18.01 | -0.0444518 | 0.0488729 | -0.0341497 | -0.0055544 | -0.0173625 | | | |
| 28/02/2022 | 9.9 | 34.540001 | 52.389999 | 50.27 | 17.700001 | -0.0614457 | -0.0407738 | -0.0119049 | -0.0309084 | -0.0211256 | | | |
| 01/03/2022 | 9.31 | 33.16 | 51.77 | 48.740002 | 17.33 | 0.03379413 | 0.02648567 | 0.05358927 | -0.0014373 | 0.0137538 | | | |
| 02/03/2022 | 9.63 | 34.049995 | 54.619999 | 48.669998 | 17.57 | -0.0533175 | 0.0237752 | -0.0617352 | -0.0201314 | -0.024778 | | | |
| 03/03/2022 | 9.13 | 33.25 | 51.349998 | 47.700001 | 17.139999 | -0.0857178 | -0.0626756 | -0.0389169 | -0.0432709 | -0.0441335 | | | |
| 04/03/2022 | 8.38 | 31.23 | 49.389999 | 45.68 | 16.4 | -0.0539346 | -0.020706 | 0.04299824 | -0.0402019 | 0.0379045 | | | |
| 07/03/2022 | 7.94 | 30.59 | 51.560001 | 43.880001 | 15.79 | 0.04192969 | 0.0251789 | 0.02641298 | -0.0038818 | -0.0127471 | | | |
| 08/03/2022 | 8.28 | 31.370001 | 52.939999 | 43.709999 | 15.59 | 0.04487175 | 0.02549309 | -0.023508 | 0.03873561 | 0.02845598 | | | |
| 09/03/2022 | 8.66 | 32.18 | 51.709999 | 45.419998 | 16.040001 | -0.0245483 | -0.028686 | -0.0003868 | -0.0238398 | -0.0157088 | | | |
| 10/03/2022 | 8.45 | 31.27 | 51.689999 | 44.349998 | 15.79 | -0.0035566 | -0.0048084 | -0.0148122 | -0.00906 | -0.0063533 | | | |
| 11/03/2022 | 8.42 | 31.120001 | 50.93 | 43.950001 | 15.69 | 0.05206497 | 0.02255851 | -0.0192295 | 0.00906003 | 0.01643526 | | | |
| 14/03/2022 | 8.87 | 31.83 | 49.959999 | 44.349998 | 15.95 | 0.00786079 | -0.0088357 | 0.00777591 | 0.00090153 | 0.01678616 | | | |
| 15/03/2022 | 8.94 | 31.549999 | 50.349998 | 44.389999 | 16.219999 | 0.04162704 | 0.03518971 | -0.0023861 | 0.01542454 | 0.0207451 | | | |
| 16/03/2022 | 9.32 | 32.68 | 50.23 | 45.080002 | 16.559999 | -0.0075391 | 0.01608774 | 0.03212811 | 0.0053097 | 0.0149838 | | | |
| 17/03/2022 | 9.25 | 33.209999 | 51.869999 | 45.32 | 16.809999 | -0.0043337 | -0.0003011 | -0.0137826 | -0.0004414 | 0.01417626 | | | |
| 18/03/2022 | 9.21 | 33.200001 | 51.16 | 45.299999 | 17.049999 | -0.0175251 | -0.0060423 | 0.04360153 | -0.0048683 | 0 | | | |
| 21/03/2022 | 9.05 | 33 | 53.439999 | 45.080002 | 17.049999 | 0.02724964 | 0.03083036 | -0.0069477 | 0.00971306 | -0.0011736 | | | |
| 22/03/2022 | 9.3 | 34.110001 | 53.07 | 45.52 | 17.040001 | -0.02174 | -0.01715151 | 0.03098294 | -0.0172838 | -0.0273827 | | | |

- Here I have calculated the volatility and expected return of each asset and of the portfolio.



- Here I have used weight of 5 different assets and calculated the variance-covariance matrix. I have graphed the EFC curve which is the blue curve line and graphed the CML line which is the orange line. CML is the Sharpe ratio of the market portfolio where it optimizes the risk/return relationship which maximizes performance.

(iv) Using linear regression analysis, calculate the *beta* for each asset in the portfolio and discuss the significance of this quantity.

Estimate Value at Risk (5%) for your portfolio and discuss how much each asset contributes to your estimated VaR.

| Date | barclays | daily share prices for 5 assets/stock | | | | | Daily Return | | | | | Beta | | | | | |
|-----------|----------|---------------------------------------|-----------|-----------|-----------|--|--------------|------------|------------|-------------|------------|---------------|-----------|------------|------------|------------|------------|
| | | HSBC | SHELL | Unilever | Vodafone | | barclays | HSBC | SHELL | Unilever | Vodafone | market return | barclays | HSBC | SHELL | Unilever | Vodafone |
| 26/1/2022 | 11.04 | 35.060000 | 50.91 | 51.310001 | 16.73 | | 0.00090508 | 0.1968052 | 0.00392852 | -0.0021438 | 0.00148404 | 7,469.78 | 48.531132 | 745.939578 | 622.617347 | -345.98991 | 299.888399 |
| 27/1/2022 | 11.05 | 35.75 | 51.110001 | 51.200001 | 16.799999 | | -0.0217195 | -0.0083916 | -0.0013696 | 0.00195309 | 0.05773816 | 7,554.31 | | | | | |
| 28/1/2022 | 10.81 | 35.450000 | 51.040001 | 51.299999 | 17.77 | | 0.00740005 | 0.0383502 | 0.00705331 | 0.00175439 | -0.0146314 | 7,466.07 | | | | | |
| 31/1/2022 | 10.89 | 35.57 | 51.400002 | 51.389999 | 17.51 | | 0.02028587 | 0.03682882 | 0.02490268 | -0.0050953 | 0.0137065 | 7,464.37 | | | | | |
| 01/2/2022 | 11.13 | 36.880001 | 52.68 | 51.310001 | 17.27 | | 0.01617251 | 0.00949021 | 0.01080005 | 0.0136906 | 0.03532131 | 7,535.78 | | | | | |
| 02/2/2022 | 11.31 | 37.23 | 53.25 | 51.200001 | 17.879999 | | -0.0044209 | -0.0077894 | 0.01239437 | 0.01132809 | 0.01677858 | 7,583.00 | | | | | |
| 03/2/2022 | 11.26 | 36.939999 | 53.91 | 51.779999 | 18.18 | | -0.0062167 | 0.01643312 | 0.02207379 | 0.0073387 | 0.00110017 | 7,528.84 | | | | | |
| 04/2/2022 | 11.19 | 37.099998 | 55.099998 | 51.400002 | 18.200001 | | 0.01304408 | 0.01212941 | 0.0110708 | 0.01653693 | 0.0142856 | 7,516.40 | | | | | |
| 07/2/2022 | 11.34 | 37.549999 | 56.709999 | 52.25 | 18.459999 | | 0.00970018 | 0.01864184 | -0.0190273 | 0.0095692 | 0.01516799 | 7,573.47 | | | | | |
| 08/2/2022 | 11.45 | 38.25 | 54.650000 | 52.299999 | 18.74 | | -0.0026020 | -0.0117647 | 0.00201274 | -0.0030598 | 0.00960512 | 7,567.07 | | | | | |
| 09/2/2022 | 11.42 | 37.779999 | 54.759998 | 52.139999 | 18.92 | | -0.0017513 | 0.01585735 | -0.0043827 | -0.0176448 | -0.0147992 | 7,643.42 | | | | | |
| 10/2/2022 | 11.4 | 37.860001 | 54.52 | 51.220001 | 18.639999 | | 0.0289474 | 0.00130207 | 0.01265589 | 0.02948065 | -0.0016093 | 7,672.40 | | | | | |
| 11/2/2022 | 11.07 | 37.810001 | 55.209999 | 52.73 | 18.610001 | | -0.0352304 | -0.0074055 | 0.0150335 | -0.02143 | -0.0118217 | 7,661.02 | | | | | |
| 14/2/2022 | 10.68 | 37.529999 | 54.380001 | 51.599998 | 18.389999 | | 0.01779026 | 0.002931 | -0.0167341 | -0.00221317 | 0.01903214 | 7,531.59 | | | | | |
| 15/2/2022 | 10.87 | 37.419998 | 53.470001 | 51.490002 | 18.74 | | -0.0082797 | -0.0069481 | 0.01066018 | 0.00757427 | 0.00693709 | 7,608.92 | | | | | |
| 16/2/2022 | 10.78 | 37.16 | 54.040001 | 51.880001 | 18.870001 | | -0.0222635 | -0.017761 | -0.007587 | -0.036623 | -0.009539 | 7,603.78 | | | | | |
| 17/2/2022 | 10.54 | 36.5 | 53.630001 | 51.688999 | 18.690001 | | 0.0047438 | 0.0084918 | -0.007272 | 0.0180112 | -0.0032104 | 7,537.37 | | | | | |
| 18/2/2022 | 10.49 | 36.810001 | 53.240000 | 52.299999 | 18.629999 | | -0.0019066 | 0.0076066 | 0.0107063 | 0.0181645 | 0.0048308 | 7,513.62 | | | | | |
| 22/2/2022 | 10.47 | 37.09 | 52.669999 | 51.349998 | 18.540001 | | 0.0257879 | 0.0037746 | -0.0007594 | 0.00486855 | -0.0118663 | 7,484.33 | | | | | |
| 23/2/2022 | 10.74 | 36.950001 | 52.630001 | 51.599998 | 18.32 | | -0.0744879 | -0.0557511 | -0.0197606 | 0.0492247 | -0.0354803 | 7,494.21 | | | | | |
| 24/2/2022 | 9.94 | 34.889999 | 51.59 | 49.060001 | 17.67 | | 0.04124748 | 0.03955291 | 0.05078502 | 0.03037093 | 0.01924165 | 7,498.18 | | | | | |
| 25/2/2022 | 10.35 | 36.27 | 54.209999 | 50.549999 | 18.01 | | -0.0434783 | -0.0476978 | -0.035731 | 0.0055391 | -0.0172126 | 7,207.38 | | | | | |
| 28/2/2022 | 9.9 | 34.540001 | 52.389999 | 50.27 | 17.700001 | | -0.059599 | -0.0399537 | -0.0118343 | 0.0304356 | -0.020904 | 7,489.46 | | | | | |
| 01/3/2022 | 9.31 | 33.16 | 51.77 | 48.740002 | 17.33 | | 0.03437164 | 0.02683394 | 0.05505117 | 0.0014363 | 0.01384882 | 7,458.25 | | | | | |
| 02/3/2022 | 9.63 | 34.049999 | 54.619999 | 48.669998 | 17.57 | | -0.0519211 | -0.0234948 | -0.0598682 | -0.0199301 | -0.0244736 | 7,330.20 | | | | | |
| 03/3/2022 | 9.13 | 33.25 | 51.349998 | 47.700001 | 17.139999 | | -0.0821468 | -0.0607519 | -0.0381694 | -0.042348 | -0.041738 | 7,429.56 | | | | | |
| 04/3/2022 | 8.38 | 31.23 | 49.389999 | 45.68 | 16.4 | | -0.052506 | -0.0204931 | 0.0493966 | -0.0394045 | -0.0371951 | 7,238.85 | | | | | |
| 07/3/2022 | 7.94 | 30.59 | 51.560001 | 43.880001 | 15.79 | | 0.04282116 | 0.02549856 | 0.02676489 | -0.0038742 | -0.0126662 | 6,987.14 | | | | | |
| 08/3/2022 | 8.28 | 31.370001 | 52.939999 | 47.709999 | 15.59 | | 0.04589372 | 0.02582082 | -0.0232339 | 0.0391214 | 0.02886472 | 6,959.48 | | | | | |
| 09/3/2022 | 8.66 | 32.18 | 51.709999 | 45.419998 | 16.040001 | | -0.0242498 | -0.0282784 | -0.003868 | -0.0235579 | -0.0155861 | 6,964.11 | | | | | |
| 10/3/2022 | 8.45 | 31.27 | 51.689999 | 44.349998 | 15.79 | | -0.0305503 | -0.0174869 | -0.014703 | 0.0090191 | -0.0063331 | 7,190.72 | | | | | |
| 11/3/2022 | 8.27 | 31.770001 | 50.93 | 49.550001 | 15.69 | | 0.05344118 | 0.02779188 | -0.0194058 | 0.00191114 | 0.01657106 | 7,094.09 | | | | | |

- Here I have calculated the betas for each individual asset.
 - I have used market index called FTSE 100 Index along with daily return of each asset to calculate beta for each individual asset.

| Regression Statistics | | | | | | | |
|-----------------------|--------------|----------------|------------|------------|----------------|------------|-------------------------|
| Multiple R | | 0.11950944 | | | | | |
| R Square | | 0.01428251 | | | | | |
| Adjusted R Square | | -0.0059166 | | | | | |
| Standard Error | | 219.62506 | | | | | |
| Observations | | 250 | | | | | |
| ANOVA | | | | | | | |
| | df | SS | MS | F | Significance F | | |
| Regression | 5 | 170531.891 | 34106.3783 | 0.70708531 | 0.61861779 | | |
| Residual | 244 | 11769380.8 | 48235.1671 | | | | |
| Total | 249 | 11939912.7 | | | | | |
| | Coefficients | Standard Error | t Stat | P-value | Lower 95% | Upper 95% | Lower 95.0% Upper 95.0% |
| Intercept | 7369.14412 | 13.971138 | 527.454823 | 0 | 7341.62469 | 7396.66354 | 7341.62469 7396.66354 |
| X Variable 1 | -956.95601 | 895.419578 | -1.0687236 | 0.2862504 | -2720.6944 | 806.782374 | -2720.6944 806.782374 |
| X Variable 2 | 1511.16759 | 1051.92748 | 1.43657012 | 0.15212111 | -560.84973 | 3583.18491 | -560.84973 3583.18491 |
| X Variable 3 | 493.792092 | 759.653616 | 0.6500227 | 0.51628908 | -1002.5235 | 1990.10764 | -1002.5235 1990.10764 |
| X Variable 4 | -748.57166 | 1065.05721 | -0.7028464 | 0.48282148 | -2846.451 | 1349.30773 | -2846.451 1349.30773 |
| X Variable 5 | 245.652139 | 923.431226 | 0.26602104 | 0.79044765 | -1573.2617 | 2064.56601 | -1573.2617 2064.56601 |

- Here I have calculated the beta for all assets combined.

| var 5% for vodafone | | | | | | | | |
|-----------------------|--------------|----------------|------------|------------|----------------|------------|-------------|-------------|
| SUMMARY OUTPUT | | | | | | | | |
| Regression Statistics | | | | | | | | |
| Multiple R | 0.02618568 | | | | | | | |
| R Square | 0.00068569 | | | | | | | |
| Adjusted R Square | -0.0033438 | | | | | | | |
| Standard Error | 219.344015 | | | | | | | |
| Observations | 250 | | | | | | | |
| ANOVA | | | | | | | | |
| | df | SS | MS | F | Significance F | | | |
| Regression | 1 | 8187.07781 | 8187.07781 | 0.17016778 | 0.68031911 | | | |
| Residual | 248 | 11931725.6 | 48111.7967 | | | | | |
| Total | 249 | 11939912.7 | | | | | | |
| | Coefficients | standard Error | t Stat | P-value | Lower 95% | Upper 95% | Lower 95.0% | Upper 95.0% |
| Intercept | 7370.60729 | 13.9051169 | 530.064388 | 0 | 7343.22011 | 7397.99447 | 7343.22011 | 7397.99447 |
| X Variable 1 | 299.888399 | 726.977543 | 0.41251398 | 0.68031911 | -1131.9489 | 1731.72567 | -1131.9489 | 1731.72567 |

- Here I have calculated value at risk at 95% co-efficient for my asset Vodafone.
- If the var is lower than 99% or 95.0% it results in negative beta value.
- If the var is higher than 95% or 95.0% it results in positive beta value.

| var 5% for barclays | | | | | | | | |
|-----------------------|--------------|----------------|------------|------------|----------------|------------|-------------|-------------|
| SUMMARY OUTPUT | | | | | | | | |
| Regression Statistics | | | | | | | | |
| Multiple R | 0.00571479 | | | | | | | |
| R Square | 3.2659E-05 | | | | | | | |
| Adjusted R Square | -0.0039995 | | | | | | | |
| Standard Error | 219.415671 | | | | | | | |
| Observations | 250 | | | | | | | |
| ANOVA | | | | | | | | |
| | df | SS | MS | F | Significance F | | | |
| Regression | 1 | 389.94341 | 389.94341 | 0.00809965 | 0.9283614 | | | |
| Residual | 248 | 11939522.7 | 48143.2368 | | | | | |
| Total | 249 | 11939912.7 | | | | | | |
| | Coefficients | standard Error | t Stat | P-value | Lower 95% | Upper 95% | Lower 95.0% | Upper 95.0% |
| Intercept | 7370.23511 | 13.8788935 | 531.039101 | 0 | 7342.89958 | 7397.57064 | 7342.89958 | 7397.57064 |
| X Variable 1 | 48.5311312 | 539.246413 | 0.08999806 | 0.9283614 | -1013.5555 | 1110.61774 | -1013.5555 | 1110.61774 |

- Here I have calculated the var of Barclays at 95% co-efficient level.

| var 5% for hsbc | | | | | | |
|-----------------------|--------------|----------------|------------|------------|----------------|-------------|
| SUMMARY OUTPUT | | | | | | |
| Regression Statistics | | | | | | |
| Multiple R | 0.07110883 | | | | | |
| R Square | 0.00505647 | | | | | |
| Adjusted R Square | 0.0010446 | | | | | |
| Standard Error | 218.863808 | | | | | |
| Observations | 250 | | | | | |
| ANOVA | | | | | | |
| | df | SS | MS | F | Significance F | |
| Regression | 1 | 60373.7566 | 60373.7566 | 1.2603765 | 0.26266553 | |
| Residual | 248 | 11879538.9 | 47901.3666 | | | |
| Total | 249 | 11939912.7 | | | | |
| | Coefficients | standard Error | t Stat | P-value | Lower 95% | Upper 95% |
| Intercept | 7369.88618 | 13.845258 | 532.303999 | 0 | 7342.6169 | 7397.15546 |
| X Variable 1 | 745.939578 | 664.436532 | 1.12266491 | 0.26266553 | -562.71844 | 2054.59759 |
| | | | | | | |
| | | | | | Lower 95.0% | Upper 95.0% |
| | | | | | | |

- Here I have calculated the var of Hsbc at 95% co-efficient level.

| var 5% for shell | | | | | | |
|-----------------------|--------------|----------------|------------|------------|----------------|-------------|
| SUMMARY OUTPUT | | | | | | |
| Regression Statistics | | | | | | |
| Multiple R | 0.06029193 | | | | | |
| R Square | 0.00363512 | | | | | |
| Adjusted R Square | -0.0003825 | | | | | |
| Standard Error | 219.020084 | | | | | |
| Observations | 250 | | | | | |
| ANOVA | | | | | | |
| | df | SS | MS | F | Significance F | |
| Regression | 1 | 43402.9709 | 43402.9709 | 0.90479788 | 0.34242457 | |
| Residual | 248 | 11896509.7 | 47969.7972 | | | |
| Total | 249 | 11939912.7 | | | | |
| | Coefficients | standard Error | t Stat | P-value | Lower 95% | Upper 95% |
| Intercept | 7369.75695 | 13.8604081 | 531.71284 | 0 | 7342.45783 | 7397.05607 |
| X Variable 1 | 622.617347 | 654.553921 | 0.95120864 | 0.34242457 | -666.57612 | 1911.81081 |
| | | | | | Lower 95.0% | Upper 95.0% |
| | | | | | | |

- Here I have calculated the var of Shell at 95% co-efficient level.

| var 5% for unilever | | | | | | | | |
|-----------------------|--------------|----------------|------------|------------|----------------|------------|-------------|-------------|
| SUMMARY OUTPUT | | | | | | | | |
| Regression Statistics | | | | | | | | |
| Multiple R | 0.02392222 | | | | | | | |
| R Square | 0.00057227 | | | | | | | |
| Adjusted R Square | -0.0034577 | | | | | | | |
| Standard Error | 219.356461 | | | | | | | |
| Observations | 250 | | | | | | | |
| ANOVA | | | | | | | | |
| | df | SS | MS | F | Significance F | | | |
| Regression | 1 | 6832.88698 | 6832.88698 | 0.14200491 | 0.70661817 | | | |
| Residual | 248 | 11933079.8 | 48117.2572 | | | | | |
| Total | 249 | 11939912.7 | | | | | | |
| | Coefficients | standard Error | t Stat | P-value | Lower 95% | Upper 95% | Lower 95.0% | Upper 95.0% |
| Intercept | 7370.23171 | 13.873393 | 531.249401 | 0 | 7342.90701 | 7397.55641 | 7342.90701 | 7397.55641 |
| X Variable 1 | -345.98991 | 918.146012 | -0.3768354 | 0.70661817 | -2154.3479 | 1462.36812 | -2154.3479 | 1462.36812 |

- Here I have calculated the var of Unilever at 95% co-efficient level.

vi) Give a summary of your findings in a non-technical language that could inform a potential investor choosing the best efficient portfolio and discuss the implication of other relevant performance measurements.

- This portfolio comprises of 5 assets or stocks in total where one year worth of data has been used, where several calculations such as volatility, expected return correlation between assets, beta of each asset, var of each asset at 95% co-efficient level, etc have been made to calculate the best portfolio. Calculation of variance-covariance matrix had to be done with using market index called FTSE 100 index to calculate the beta of each asset which shows the statistical volatility measurement of a stock versus the whole market. This shows the level of risk an asset comprises of and gives a glimpse of which asset will be reliable in terms of weight than the other, so a beta can serve as a measurement of investment. If a beta is positive, it means that it tends to move in the same direction as the market and if the beta is negative, it means it tends to move the opposite direction to the market. In the portfolio, only unilever has a negative beta making it the least reliable asset to invest in as the only time it will have an advantage and an increase in price is when the whole market price falls. The other 4 assets have a positive beta where Vodafone seems to be the most reliable as its beta is not as high as HSBC and shell and as not as low as Barclays. In terms of investing putting more weight on positive beta stocks and less weight in negative beta stock would be an appropriate way of having an efficient portfolio for an potential investor. Efficient portfolio curve was used to represent the maximum returns for assumed risk of a portfolio, which shows estimate of returns for a risk a investor might take or want to take, which is represented graphically in the portfolio as well.