**MEGC72H3 – Financial Economics**

**Assignment #2**

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1. The following table shows the summary of our portfolio, which includes the arithmetic and geometric means, the standard deviation and the variance of all four of the stocks in the portfolio. The standard deviation shows the risk of each stocks and the average and the geometric mean is the expected return for each asset monthly. The Portfolio column gives equally weighted average and Geometric mean and St. Deviation and variance of the all four stocks. Note, the Portfolio column has been calculated prior to this work and thus calculations are not included in this Excel package. To calculate the Portfolio values, we multiplied returns of each of the stock by 25% and added them up.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Portfolio Summary** |  |  |  |  |  |
|  | JPM | MSFT | PFZ | MSN | Portfolio |
| Average | 1.0118% | 1.0186% | 0.6957% | 1.1495% | 14.1572% |
| Geometric mean | 4.7983% | 0.7644% | 0.5463% | 3.5309% | 13.3083% |
| St. Deviation | 8.6517% | 7.2039% | 5.4691% | 8.1641% | 13.8970% |
| Variance | 0.7485% | 0.5190% | 0.2991% | 0.6665% | 1.9313% |
| Weight | 25.0000% | 25.0000% | 25.0000% | 25.0000% | 100.0000% |

1. The following table is the variance and covariance matrix for the four stocks above. The diagonal values of the matrix are the variances of the returns on each stock and the others represent covariance of the return. We used the Data Analyst tool-pack in Excel, to calculate the covariance matrix with input being our monthly returns for each of the four stocks. The covariance matrix given is a lower triangle matrix; to complete the matrix we transpose the matrix onto itself. The following matrix shows the complete covariance matrix.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **VARIANCE COVARIANCE MATRIX** | | |  |  |
|  | JPM | MSFT | *PFZ* | MSN |
| JPM | 0.288082938 | -0.002189043 | 0.001796478 | 0.001342395 |
| MSFT | -0.002189043 | 0.005145946 | 0.001186102 | 0.002236647 |
| PFZ | -0.001796478 | 0.001186102 | 0.002965961 | 0.001020674 |
| MSN | 0.001342395 | 0.002236647 | 0.001020674 | 0.006609175 |

1. To calculate the mean variance portfolio we use the geometric mean of each stocks and the covariance matrix. Here we attempt to minimize the variance hence minimizing the risk at a specific level of return. The variance of the portfolio is the sum of the weighted variance of each stock. The Sharpe ratio is expected returns divided by the standard deviation of the portfolio. The return of the portfolio is the sum of the weighted return for each stock. As we change the weight, the portfolio’s expected return, standard deviation and the Sharpe ratio changes as well. Using the Solver in Excel, we get the weights of stocks in the portfolio, which will minimize the variance at a specific level of expected return. For the Short Sell allowed case, we set values of expected returns from 0.035% to 4.00 %, with minimum standard deviation occurring at expected return of 0.035% and maximum Sharpe Ratio occurring at the expected return of 3.8612%. For No Short Sell allowed case we set values of expected returns from 0.5463% to 3.7, with minimum standard deviation occurring at expected return of 0.5463% and maximum Sharpe Ratio occurring at the expected return of 3.5067%. This will give a data set of the weights for each stock. To find min. variance portfolio given the target return, we set the sum of weights equal to zero, the product of weights and geometric returns of each stock equal to the target rate, and set min option in Solver. To find the maximum Sharpe ratio, we set max option in Solver and set the sum of weights equal to 1. For the No Short Sell allowed, we just add the constraint stating that all of the weights must be greater than 0.

The following two tables show a sample of the optimal portfolio calculations. The first row shows the target returns. Second row contains standard deviations. Third row contains Sharpe Ratios. Rows 4 to 7 contain calculated weights for each of the stocks in the portfolio. The last row contains the points on the Capital Allocation Line. The first column identifies where the standard deviation is minimized and its associate return and weights. The complete data set for both can be been the in Excel file.

Mean-variance efficient portfolio – Short sale

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Mean** |  | 0.0350% | 0.1000% | 0.4700% | 0.8400% | 1.2100% | 1.5800% | 1.9500% |
| **SD** | 3.0000% | 5.5214% | 5.4317% | 5.0057% | 4.7498% | 4.6920% | 4.8393% | 5.1744% |
| **Sharpe** | | 0.6339% | 1.8410% | 9.3893% | 17.6849% | 25.7886% | 32.6491% | 37.6859% |
| **JPM** |  | 0.0067 | 0.0070 | 0.0089 | 0.0108 | 0.0128 | 0.0147 | 0.0166 |
| **MSFT** |  | 0.3881 | 0.3783 | 0.3224 | 0.2665 | 0.2107 | 0.1548 | 0.0989 |
| **PFZ** |  | 0.8144 | 0.8019 | 0.7305 | 0.6591 | 0.5878 | 0.5164 | 0.4450 |
| **MSN** |  | -0.2092 | -0.1872 | -0.0619 | 0.0635 | 0.1888 | 0.3142 | 0.4395 |
| **CAL** | 1.3361% | 2.4592% | 2.4192% | 2.2295% | 2.1155% | 2.0897% | 2.1554% | 2.3046% |

Mean-variance efficient portfolio – No Short sale

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Mean** |  | 0.5463% | 0.8000% | 1.1000% | 1.4000% | 1.7000% | 2.0000% | 2.1000% |
| **SD** | 2.0000% | 5.4461% | 4.7683% | 4.6876% | 4.7426% | 4.9288% | 5.2323% | 5.3563% |
| **Sharpe** |  | 10.0316% | 16.7775% | 23.4663% | 29.5196% | 34.4908% | 38.2242% | 39.2064% |
| **JPM** |  | 0.0000 | 0.0106 | 0.0122 | 0.0137 | 0.0153 | 0.0168 | 0.0173 |
| **MSFT** |  | 0.0000 | 0.2726 | 0.2273 | 0.1820 | 0.1367 | 0.0914 | 0.0763 |
| **PFZ** |  | 1.0000 | 0.6669 | 0.6090 | 0.5511 | 0.4932 | 0.4354 | 0.4161 |
| **MSN** |  | 0.0000 | 0.0499 | 0.1515 | 0.2532 | 0.3548 | 0.4564 | 0.4903 |
| **CAL** | 0.8819% | 2.4015% | 2.1027% | 2.0671% | 2.0913% | 2.1735% | 2.3073% | 2.3619% |

1. First we look at the case where we are allowed to short sale in this portfolio meaning the weights can vary between -1 and 1 with the total sum of weights of 1. For the graph below, we see that the minimum standard deviation is 5.5214%with expected return of 0.035% Any point below this expected return is not efficient because those points give a lower return for a higher risk. Therefore, an individual should choose any point above the 0.035%. Additionally, the Sharpe ratio is a reward to risk ratio, which was maximized at mean of 3.8612% and the standard deviation of 8.6693% and the Sharpe ratio is at 44.5382%. This is the optimal risky portfolio assuming that the risk free rate is 0. The following graph below shows a curvature towards the left for any point above the minimum variance portfolio on the efficient frontier. This impose that there is a negative correlation between the stocks in the portfolio.
2. Now we look at the case where we are not allowed to short sale in this portfolio meaning our weights must be greater than or equal to zero with the total sum of weights of 1. This implies that the none of the weights in the portfolio can hold negative value. For the graph below shows a minimum variance at 5.4461% and the return of 0.5463%. Any point below this is not efficient because those points give a lower return for a higher risk. Therefore, an individual should choose any point above the minimum variance or that point depending on the degree of risk aversion. Additionally, the Sharpe ratio is a reward to risk ratio, which was maximized at mean of 3.5067% and the standard deviation of 7.9524% and the Sharpe ratio is at 44.0967%. This is the optimal risky portfolio assuming that the risk free rate is 0.
3. To find the CAL, we take the standard deviation of each of the expected returns and multiply it by the maximum Shapre Ratio. As we can see, the slope of each CAL is the Sharpe ratio. Short Sale case higher slope but lower intercept compared to the No Short Sale case. As we can see, for the Short Sale case, the risk free rate is 7E-17%; For the No Short Sale case, the risk free rate is 1E-16%.