

## A Guide to the Interactive Portfolio Optimizer

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### The Set-Up and Some Insights

1) The initial screen you will see when opening the optimizer (distributed via email) on your computer is reproduced as Table 1. Column A, lines 2-7, lists the 6 available assets. Asset 0 (in line 2) is the risk free asset. It has a mean return of 4.0% (see column B) and a standard deviation of 0.0% (see column D). There are 5 risky assets, beginning with asset 1 in line 3 (a mean return of 5% and a standard deviation of 16%) and ending with asset 5 in line 7 (a mean return of 12% and a standard deviation of 21%).

2) Columns C and D contain up and down arrows that allow you to change the values for each of the numbers with a click of your mouse. (Leave them alone for now.)

3) The risk/return graph under columns F through H shows the five risky assets as large (blue) dots inside the efficient frontier (it is easy to recognize asset 1 sitting below the others above the 15% standard deviation on the horizontal axis). Recall that the efficient frontier is constructed by combining risky securities so that the risk is minimized for every return. The parabolic shape of the frontier comes from this minimization process. The risk free asset is the (red) dot on the vertical axis right below the 5% mark.

4) You should recognize the (black) dot representing the 'global' minimum variance portfolio as the extreme left point on the efficient frontier of risky assets. (Recall that points on the frontier below and to the right of this point are dominated by this global minimum variance portfolio and, therefore, are not efficient choices.) You should also be able to recognize the (green) dot showing the tangency point between the line starting at the risk free rate and the efficient frontier of risky assets. This line is the capital allocation line. Recall that the tangency point identifies the optimal portfolio of risky assets.

5) The fraction allocated to each risky asset (their weights) in this optimal portfolio of risky assets has been calculated by the optimization and appears under column J. (These weights are also displayed in a bar chart in cells A9 to D13). The composition of the risky assets in the global minimum variance portfolio appears under column K. Notice that the weights of the risky assets in these two portfolios are quite different. In other words, a mutual fund must have different allocations when representing that its portfolio is the optimal risky combination to trade off against the risk-free asset compared with the allocation needed for the global minimum variance portfolio. Comparing column K with column J shows that the global minimum variance portfolio is more evenly balanced among the five risky assets while the optimal risky portfolio overloads on asset 2.

6) Another interesting insight into the difference between the global minimum variance portfolio and the optimal risky portfolio comes from the simple experiment of increasing the mean return on one of the risky assets. For example, doubling the mean return of risky asset 1 in line 3 from 5 % to 10 % leaves the composition of the global minimum variance portfolio unchanged while increasing the allocation to risky asset 1 in the optimal risky portfolio. **USE THE UP ARROW IN COLUMN C OF ROW 3 TO CHECK THIS YOURSELF.**

7) One outcome of the overload on asset 2 in the optimal risky portfolio is a higher mean return expected for that portfolio compared with the global minimum variance portfolio. This can be seen in the risk/return graph where the (green) tangency dot is at about the 13% level on the vertical axis while the (black) global minimum dot is at about the 10 % level.

8) The correlation coefficients that enter into the calculation of efficient portfolios appear in a matrix displayed in cells J9 to N13. In the initial set-up, all of the correlation coefficients are zero. You may change these correlations by clicking on the up and down arrows beneath the table. Note that because the correlations are symmetric the toggle buttons apply to only half of the table (also note that you cannot change the 100% (1.0) correlation of each asset with itself that appears on the diagonal).

### **Lessons on Correlations Among Returns**

9) The portfolio allocations (weights) for the risky assets in the optimal portfolio (under column J) reflect the means, standard deviations and correlations that appear in the tables. The largest allocation (52.97%) goes to risky asset 2 because its mean return is so high relative to its standard deviation compared with every other risky asset. In fact, it dominates every other risky asset. Nevertheless, because the correlation coefficients among the risky assets are so low (zero), all risky securities enter into the composition of the optimal portfolio as ‘risk reducers’. Similarly, even asset 4, with a lower mean but the same standard deviation as asset 5, enters the optimal portfolio with a positive weight because of its risk reducing role.

10) We can see the importance of low correlation by raising the correlation coefficient between assets 4 and 5 from zero to 70% (click on the ‘up arrow’ in cell M17 to do this yourself). The results appear in Table 2. Notice that the allocation to the ‘poorly endowed’ asset 4 is driven down to 1.70% of the optimal risky portfolio. Its value as a risk reducer has been damaged by its high correlation with asset 5 and its contribution is further limited by the fact that asset 5 has a higher mean with the same standard deviation.

### **Extensions**

11) You can play with the optimizer to see how the efficient frontier and optimal allocations change with new assumptions for the means, standard deviations and correlations among the assets. See if you can figure out why the allocations change the way they do. Sometimes it will be clear while other times it may be less so.

12) See what happens if the correlation between assets 4 and 5 were .9 (90%). You will observe a negative 13.92% ‘invested’ in asset 4, meaning asset 4 is sold short in that fraction of the portfolio. Where do most of the proceeds of the short sale go? Asset 5 now makes up 30.15% of the portfolio compared with only 16.11% when the correlation is .7 in Table 2. The portfolio optimizer suggests taking advantage of the high correlation between these two securities to capture the higher return on asset 5 compared with asset 4. The risk of this long position in asset 5 financed by the short position in asset 4 is low because the two securities returns move so closely together.