

Lab Week 5 (Opportunity Set w/ 2 Risky Assets):

Step 1 (Get the Sample Moments): Go to Yahoo Finance, and obtain the monthly closing prices for the Russell 2000 (ticker symbol “^RUT”) and the S&P 500 (ticker symbol “^GSPC”). Leave the default dates chosen by Yahoo; this gives all the data currently available.

Using cut and paste, merge these closing prices into a single spreadsheet. Delete all the extraneous stuff (Open, High, etc.). Compute monthly returns. Delete all the return data for the S&P for which we have no comparable Russell data (i.e., delete everything pre-Oct 1987). This ensures we are comparing apples to apples. Then find sample moments of these two returns as indicated in the screenshot below.

	A	B	C	D	E	F	G	H
1	Date	RUT Close	GSPC Close	RUT Return	GSPC Return		Sample Moments	
2	2/2/2009	445.77	827.16	0.0050504	0.00154986		RUT Mean	
3	1/2/2009	443.53	825.88	-0.111963	-0.0856573		GSPC Mean	
4	12/1/2008	499.45	903.25	0.0556072	0.00782157		RUT St Dev	
5	11/3/2008	473.14	896.24	-0.119772	-0.074849		GSPC St Dev	
6	10/1/2008	537.52	968.75	-0.209041	-0.1682693		Covariance	
7	9/2/2008	679.58	1164.74	-0.081028	-0.0920543		Correlation	
8	8/1/2008	739.5	1282.83	0.0349605	0.0121905			
9	7/1/2008	714.52	1267.38	0.0360467	-0.0098594		t-test (Column D vs. E)	
10	6/2/2008	689.66	1280	-0.07834	-0.0859624		F-test (Column D vs. E)	

The excel formulas for covariance and correlation are =COVAR() and =CORREL().

Step 2 (Statistical test of difference in means, variances): The values in cells H2 and H3 are not equal. But can we reject the hypothesis that the true means of the underlying distributions are equal? Roughly, would the observed difference between H2 and H3 be consistent with “normal” levels of statistical variation *if they had the same true mean*? In cell H9 enter the formula

=ttest(, ,2,3)

In the first two blank spaces you will put the returns of RUT and GSPC, respectively.

The “2,3” at the end of the formula are relatively minor details I didn’t emphasize much in class. The “2” indicates we want to use a two-tailed test (i.e., putting 2.5% in each tail). The “3” indicates we are conducting the test assuming heteroskedasticity (i.e., do not force Excel to assume the variances in each sample are the same). You can see for yourself that replacing this with a “2” (instead assuming homoskedasticity) makes hardly any difference.

In cell H10, conduct the analogous test for difference in variance. The formula is =FTEST().

The output of each of these formulas is a p-value. Using the most standard significance level, we would **reject equality** if this number is less than .05.

Recalling the theme of the course – first moments are noisy, and we can’t say much useful about them without an extraordinary amount of data – you should anticipate very different output in cells H9 and H10.

Step 3 (Building the Opportunity Set): In columns J through M, create a sequence of candidate portfolios. In cells J2:J20, use “fill series” with step value .05 to create 21 different portfolios from w=0 to w=1.

J	K	L	M
Weight in RUT	Variance of Portfolio	St. Dev of Portfolio	E(r) of Portfolio
0			
0.05			
0.1			
0.15			
0.2			
0.25			
0.3			
0.35			
0.4			
0.45			
0.5			
0.55			
0.6			
0.65			
0.7			
0.75			

In cell K2, compute the variance of the portfolio using the formula from class. From class, we know that variance is

$$Variance = (w_A\sigma_A)^2 + (w_B\sigma_B)^2 + 2w_Aw_B\sigma_{AB}$$

So, in cell K2 you enter

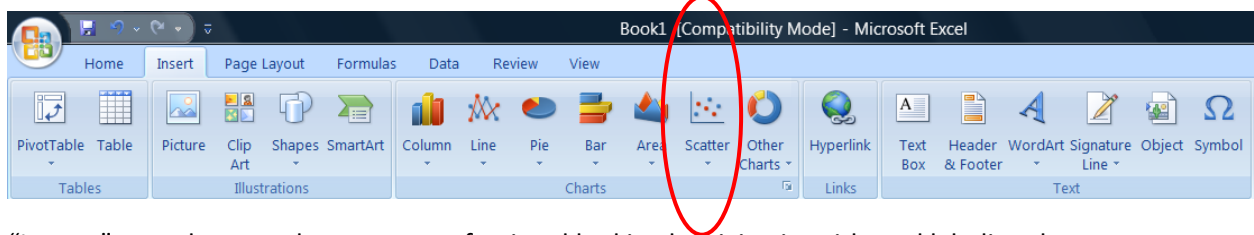
$$=(J2*H\$4)^2+((1-J2)*H\$5)^2+2*J2*(1-J2)*H\$6$$

The dollar signs before the numbers in column H ensure that once we fill down, the weights (J2) advance while the references to the sample moments in column H stay fixed. Compute the standard deviation as the square root of the variance, and the E(r) as the weighted average of the two returns.

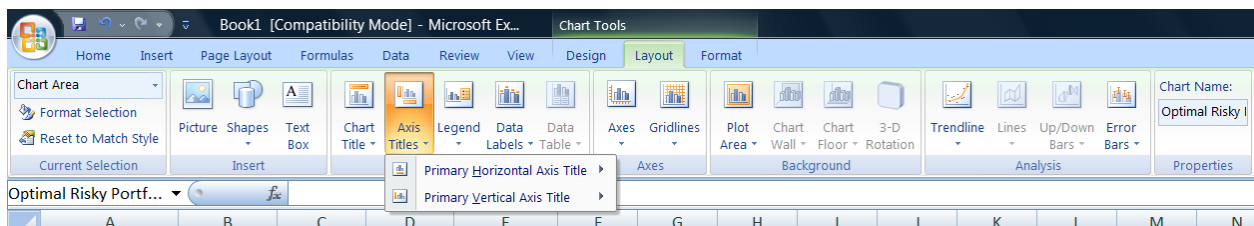
Check: Make sure everything so far makes sense:

- For w=0 you should get the mean and standard deviation of GSPC.
- For w=1 you should get the mean and standard deviation of RUT.
- As you go from w=0 to w=1, the mean should gradually transition from the mean of asset GSPC to that of RUT. You should see the same effect for standard deviation, except it may initially decrease due to the diversification effect.

Highlight cells L2:M22 and then produce a scatterplot of standard deviation vs. expected return.




Use “Layout” to make your chart more professional looking by giving it a title and labeling the axes.

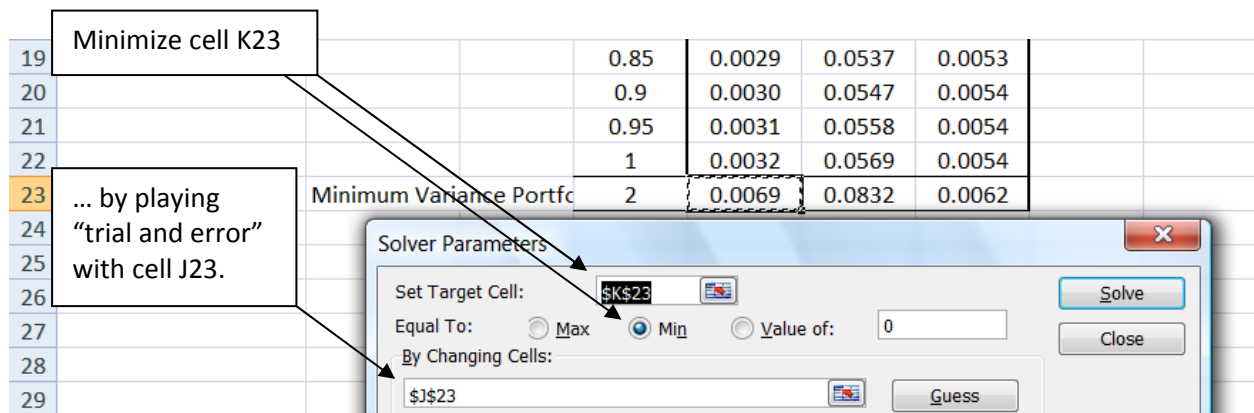


Step 4 (Minimum Variance Portfolio): Which portfolio weights would give the smallest possible variance?

To answer this question, go down to the row 22 (where weight=1) and fill down one more row of columns J through M. Excel will try to find some pattern, so it might pick a weight of 2, but this is not important.

You then want to do trial-and-error on cell J23 (trying different weights) until you find the smallest variance. Excel's **solver** function automates this task.

Under the "Data" tab, click on **solver**. (From the "Start" icon  you'll have to add in solver if you didn't already do so.) Ask solver to experiment with different portfolio weights until it minimizes variance, like so...



The screenshot shows an Excel spreadsheet with a table of portfolio weights and variances. The table is titled "Minimum Variance Portfolio" and has columns for weight, variance, and other metrics. The Solver Parameters dialog box is open, showing the target cell as \$K\$23 and the goal as Min. The "By Changing Cells" field is set to \$J\$23. Two callout boxes provide instructions: "Minimize cell K23" and "... by playing 'trial and error' with cell J23."

Weight	Variance	Other Metric 1	Other Metric 2
0.85	0.0029	0.0537	0.0053
0.9	0.0030	0.0547	0.0054
0.95	0.0031	0.0558	0.0054
1	0.0032	0.0569	0.0054
2	0.0069	0.0832	0.0062

Solver Parameters dialog box:
Set Target Cell: \$K\$23
Equal To: Max Min Value of: 0
By Changing Cells: \$J\$23
Buttons: Solve, Close, Guess

Choose "keep solver solution."

Step 5 (More Experimentation): Finally, play with your sample moments. Change them and see how the opportunity set is graphically altered. Re-run solver to see how your minimum variance portfolio changes.