Note on Using Excel to Compute Optimal Risky Portfolios

Constructing Efficient Portfolios Using MarkowitzII.xls

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Introduction

This document shows how to,

(1) Compute the expected return and standard deviation of a portfolio of N given risky assets;

(2) Construct the portfolio that gives the highest rate of return for a given standard deviation;

(3) Construct the portfolio that has the lowest standard deviation for a given expected return;

(4) Construct the tangent portfolio that has the the steepest capital allocation line CAL when combined with the risk-free rate of asset;

(5) Compute the optimal combination of the tangent portfolio and the risk-free asset for a risk averse investor;

using *MarkowitzII.xls* (© 2000, Ravi Jagannathan and Andrew Kaplin)

You will require the following information for using *MarkowitzII.xls*.

a. Expected returns, standard deviations, and the correlation matrix for the N risky asset returns;

b. The risk-free rate of return;

c. The risk aversion coefficient, A, of the investor that relates the certainty equivalent rate of return of a risky asset to its expected return and standard deviation [1]:

Certainty Equivalent Rate of Return = (Expected Return) - .005×A×(Variance of Returns).

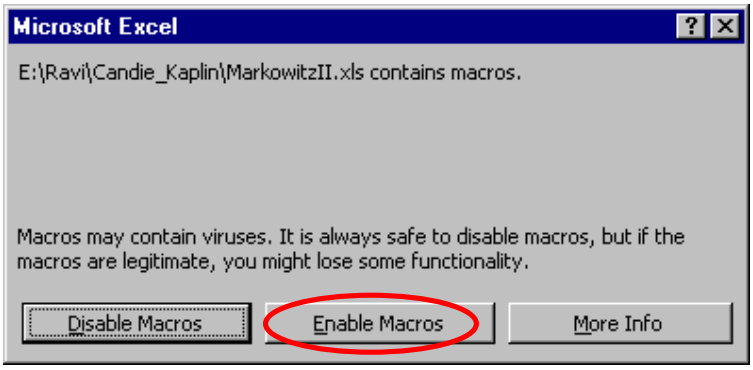
You have the expected returns, standard deviations, and a correlation matrix for IBM, COLEX, ATX, HPX, IRWINX, and BORYLAND. The risk-free rate of return is 1.4% and the aversion coefficient is 25.

[1] See Bodie, Zvi, Alex Kane and Alan J. Marcus, *Investments* (Homewood, Illinois: Irwin, Fourth Edition 1999)

Section 1: Entering the inputs

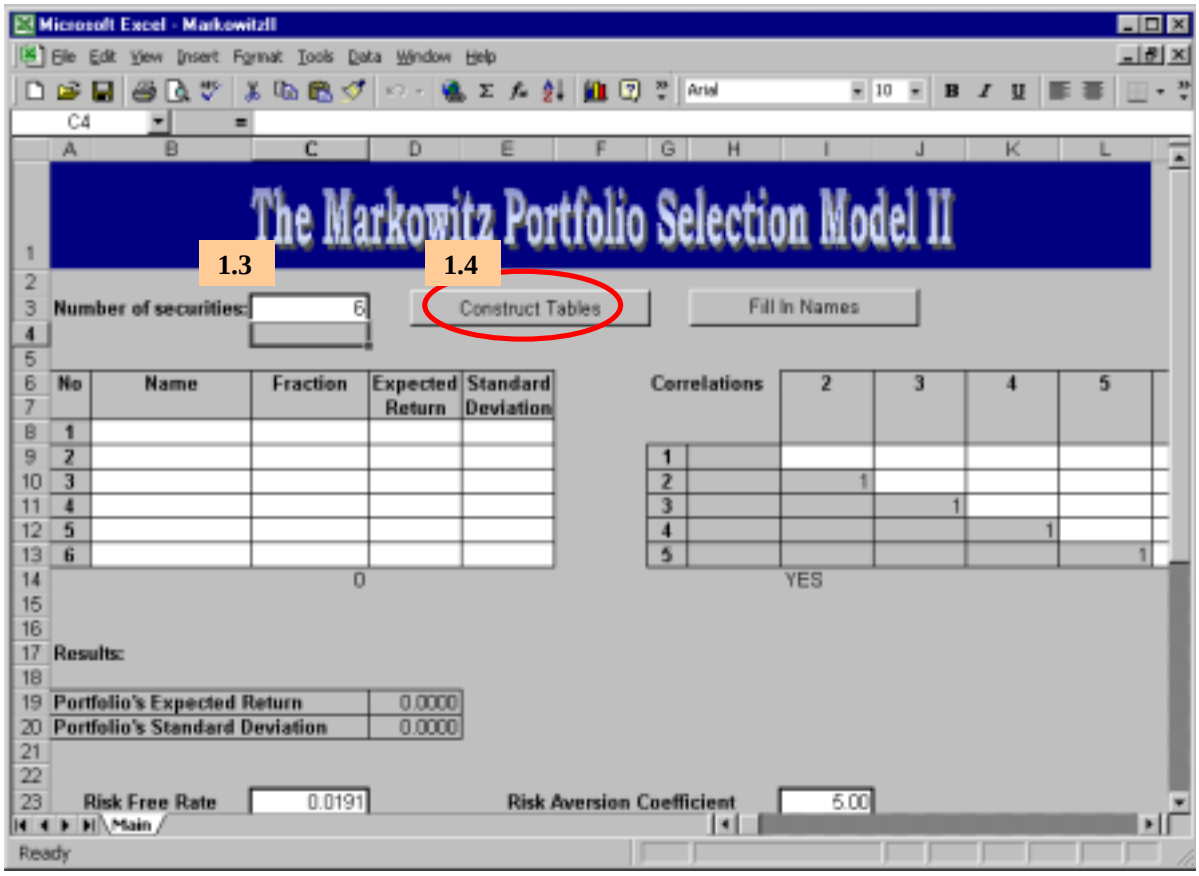
1.1. Open *MarkowitzII.xls*

1.2. Enable Macros.

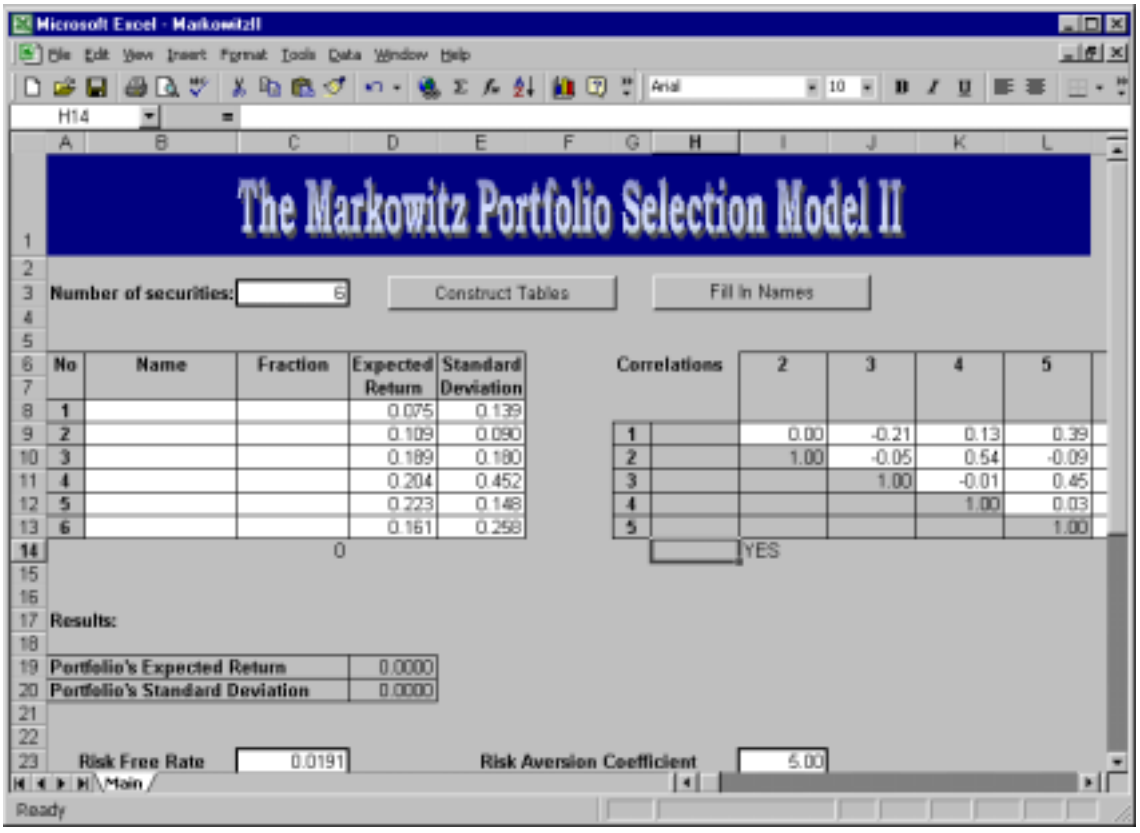


1.3. Input 6 (=N) in the cell C3 for the **Number of Securities** and **press the Enter key ↵**

1.4. Click the button **Construct Tables.**

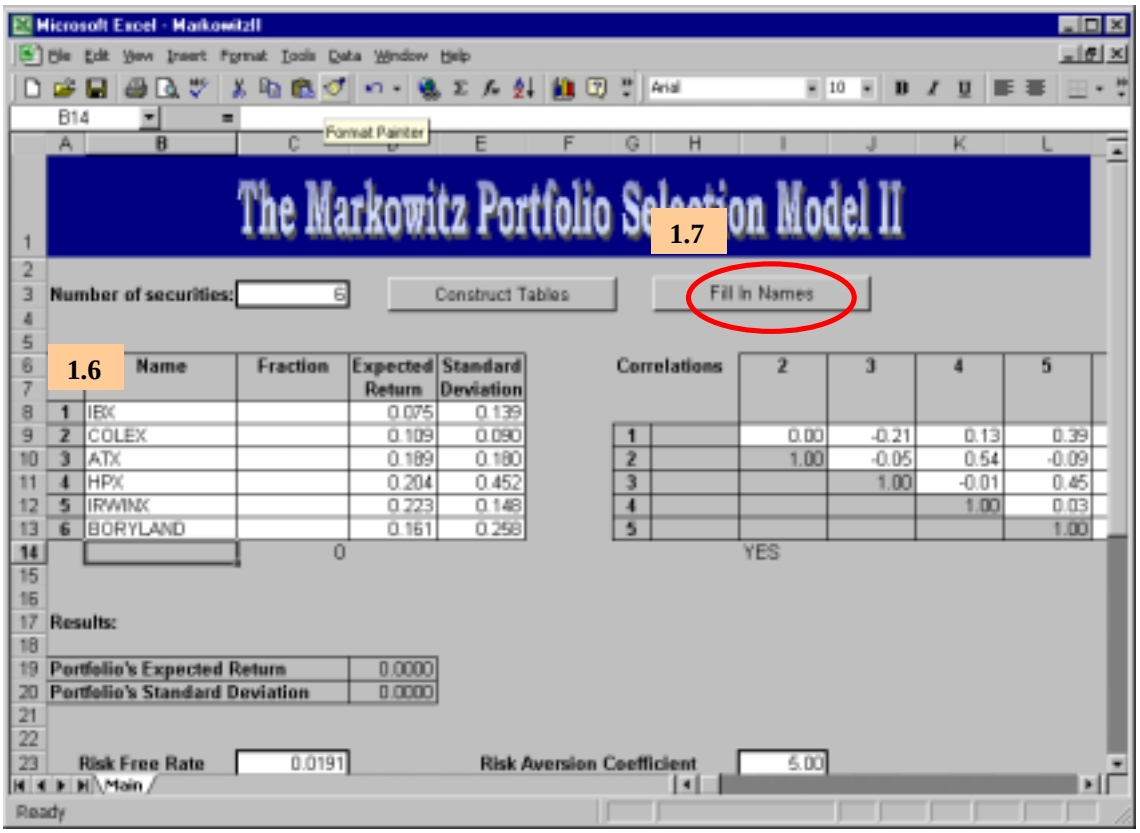


1.5. Input the means, the standard deviations and the correlation matrix as follows.

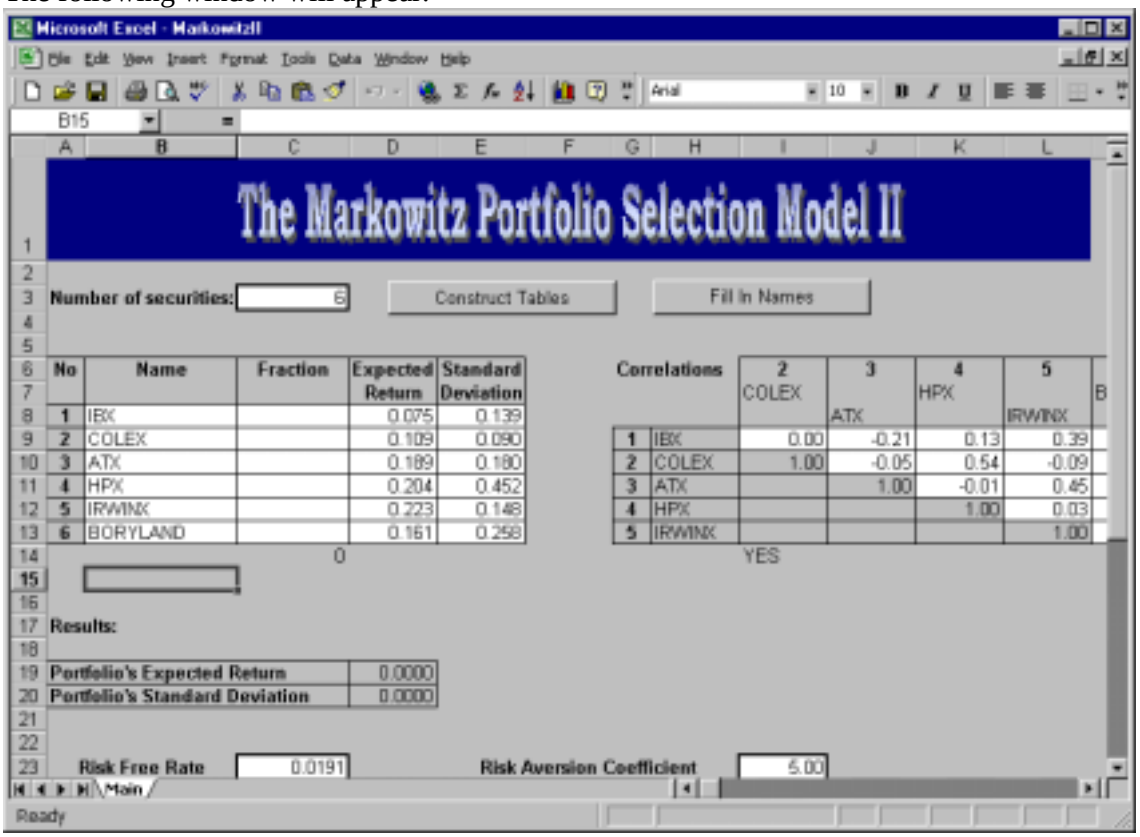


1.6. Input the names of the securities in Row B as follows.

1.7. Click the button **Fill in Names** to fill the names for the correlation matrix**.**

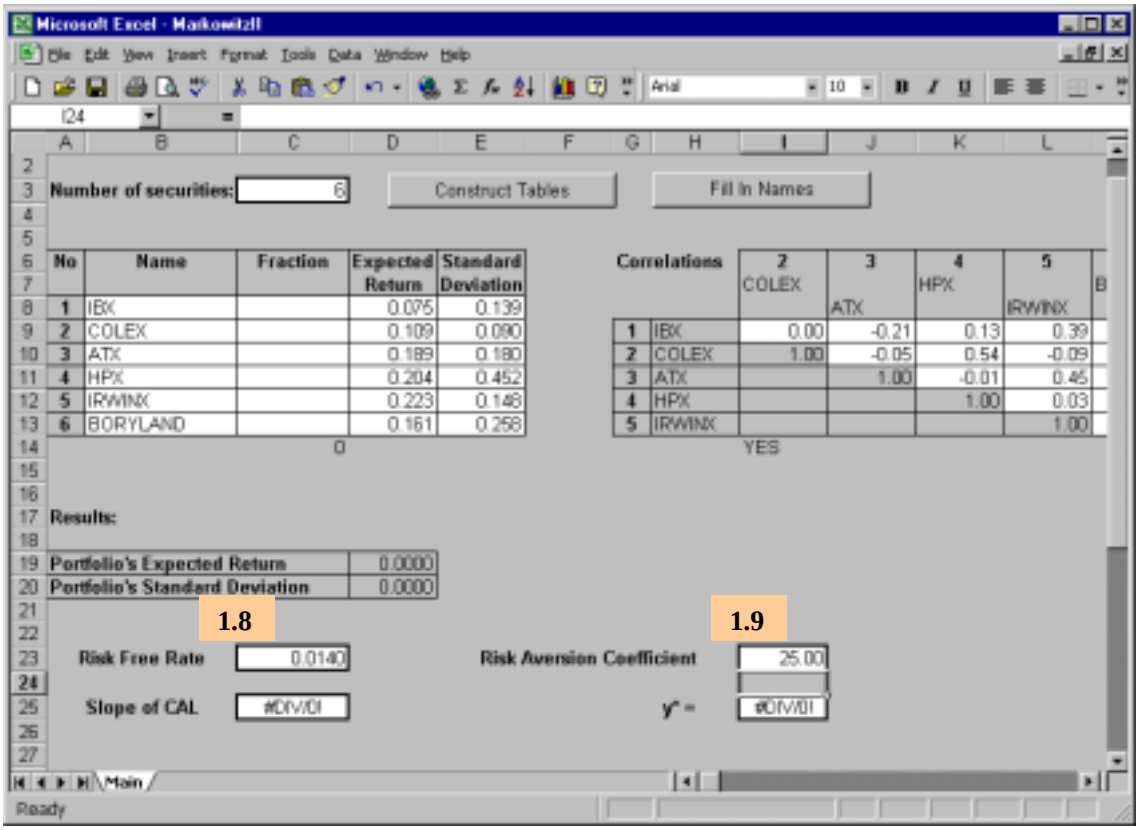


The following window will appear.



1.8. Input 0.014 in the box **Risk Free Rate.**

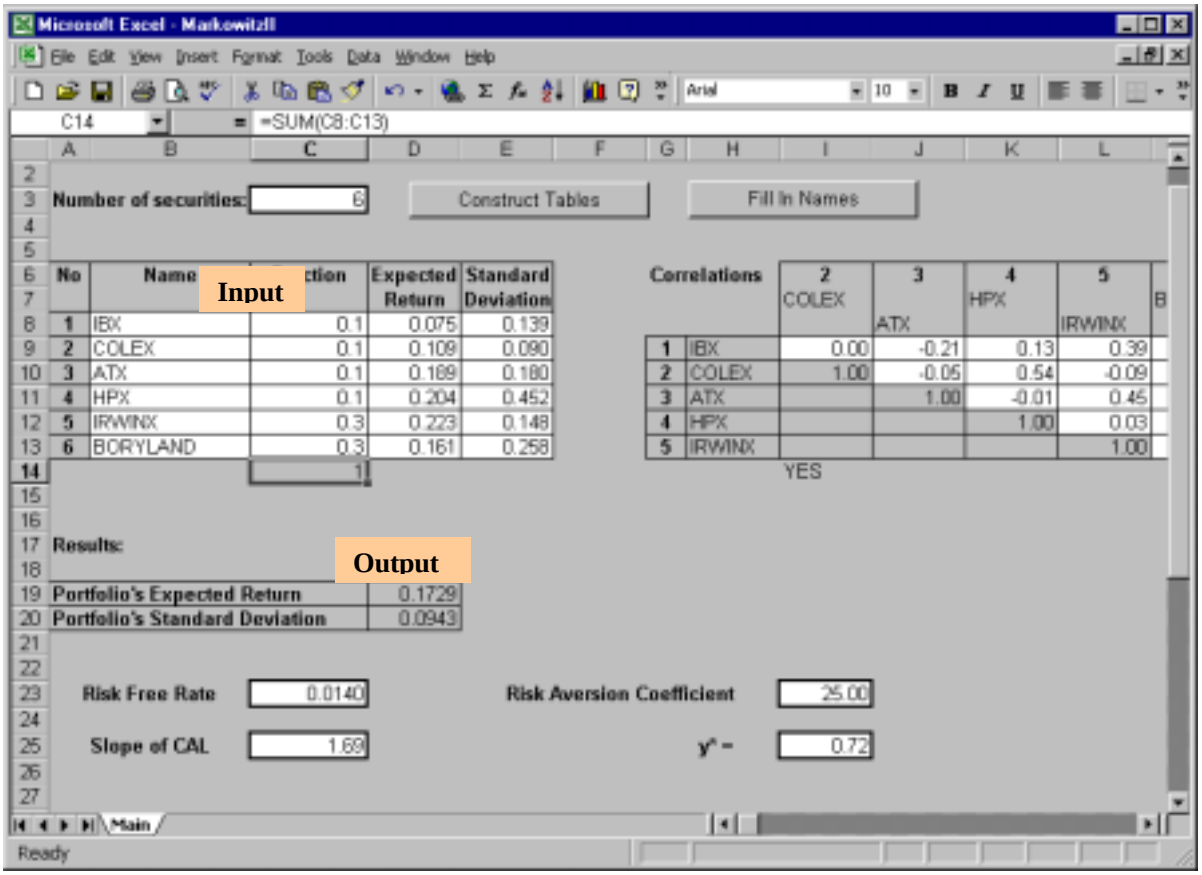
1.9. Input 25 in the box **Risk Aversion Coefficient** and **press the Enter key ↵**



Section 2: Calculating the Expected Return and Standard Deviation for an Arbitrary Portfolio

Input the portfolio weights (fractions) of the investment on each of the N risky assets in row C to obtain

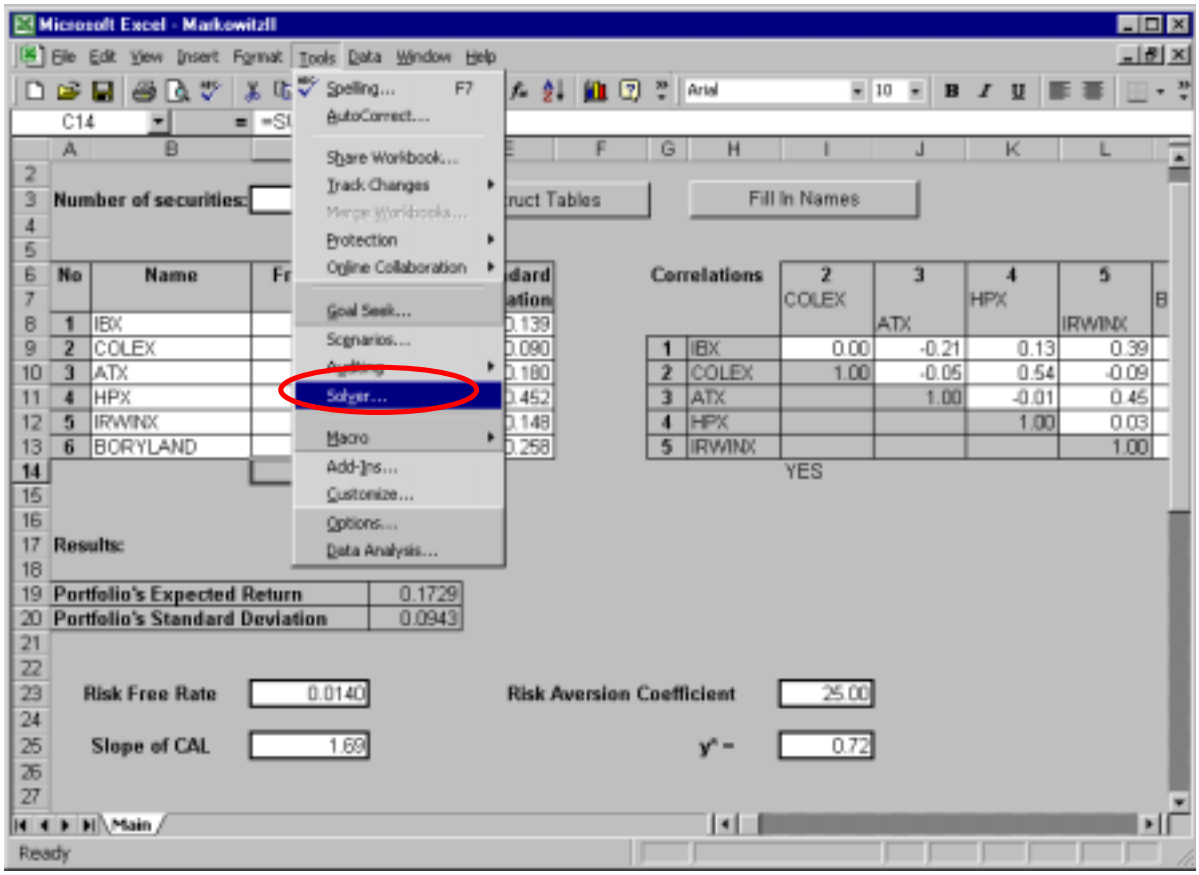
(1) The expected return and standard deviation of a portfolio of N given risky assets.



Section 3: Calculating Optimal Portfolios

3A. The highest rate of return for a given level of standard deviation

3A.1. Click Tools on the menu bar and **choose Solver …**

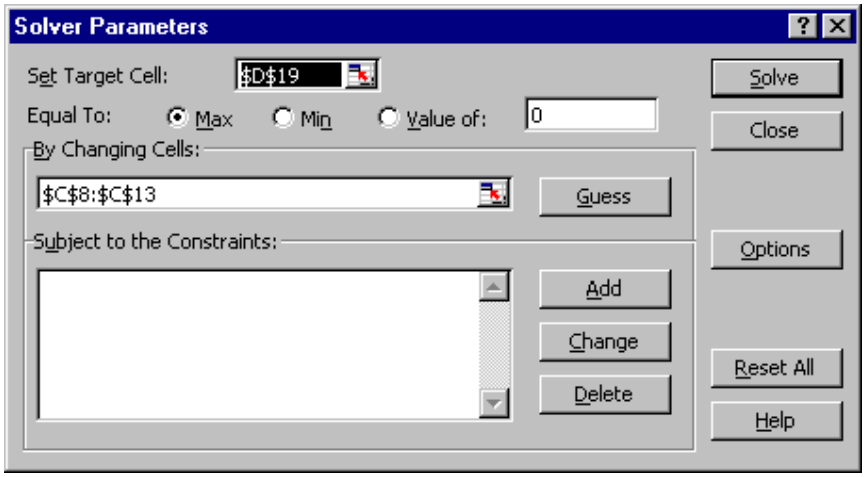


3A.2. In the Solver Parameters window, choose "maximize" to maximize the portfolio's expected return:

Set Target Cell: $D$19 the cell that contains the portfolio's expected return

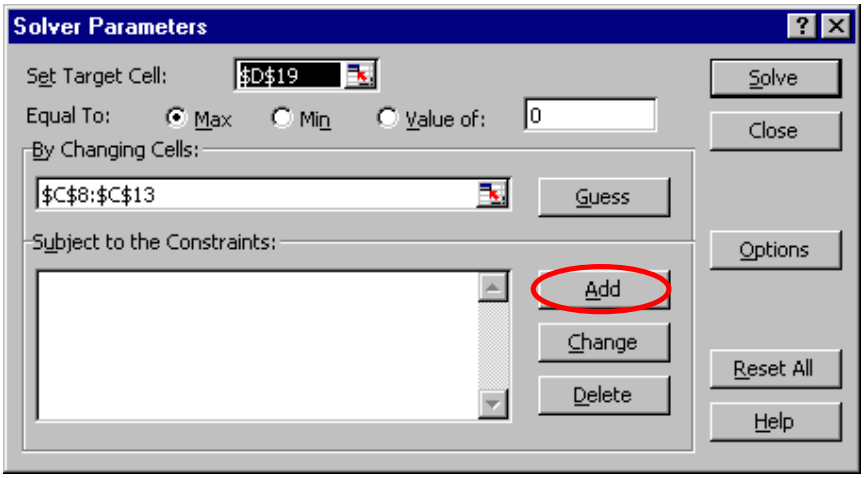
Equal To: ⊙ Max

By Changing Cells: $C$8:$C$13 the cells that contain the weights for the 6 assets.



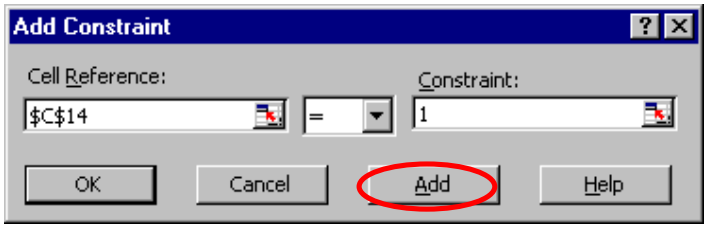
Suppose that the maximum risk level you would like to take is 8.5%.

3A.3. You have to **add the following constraints.**[2]



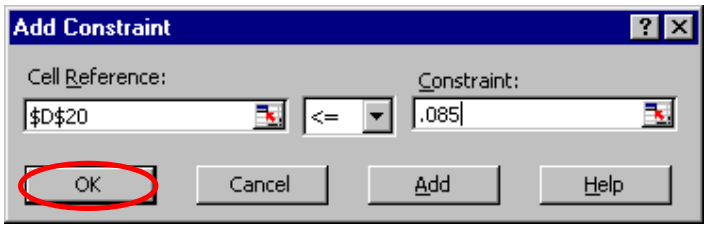
Constraint 1: **$C$14** the cell recording the sum of the weights (=sum($C$8:$C$13)) equals (=) **1**.

Press the button **Add** to add the second constraint.

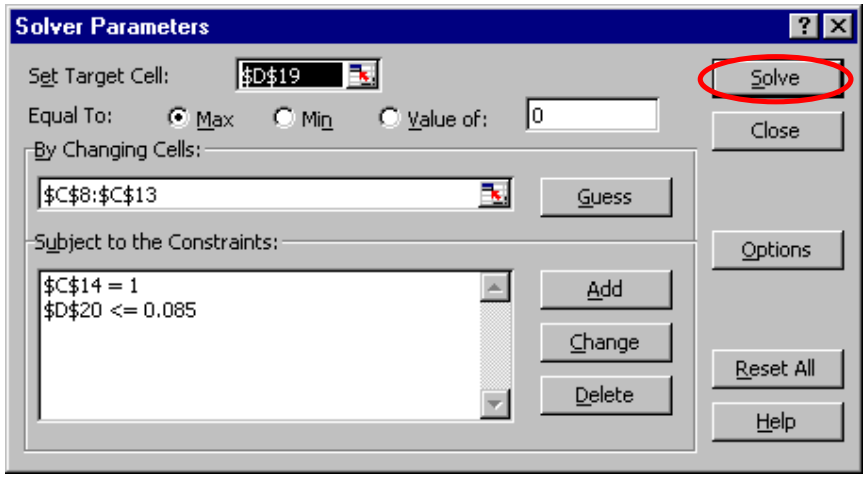


Constraint 2: $D$20 the cell recording the portfolio's standard deviation **is no more than** (<=) **0.085**.

Press the button **OK** to return to the Solver Parameters window.

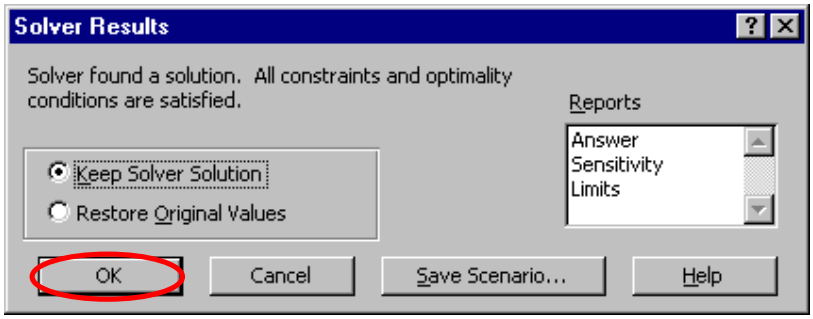


3A.4. The following window will appear. **Press** the button **Solve** to obtain the desired optimal portfolio.

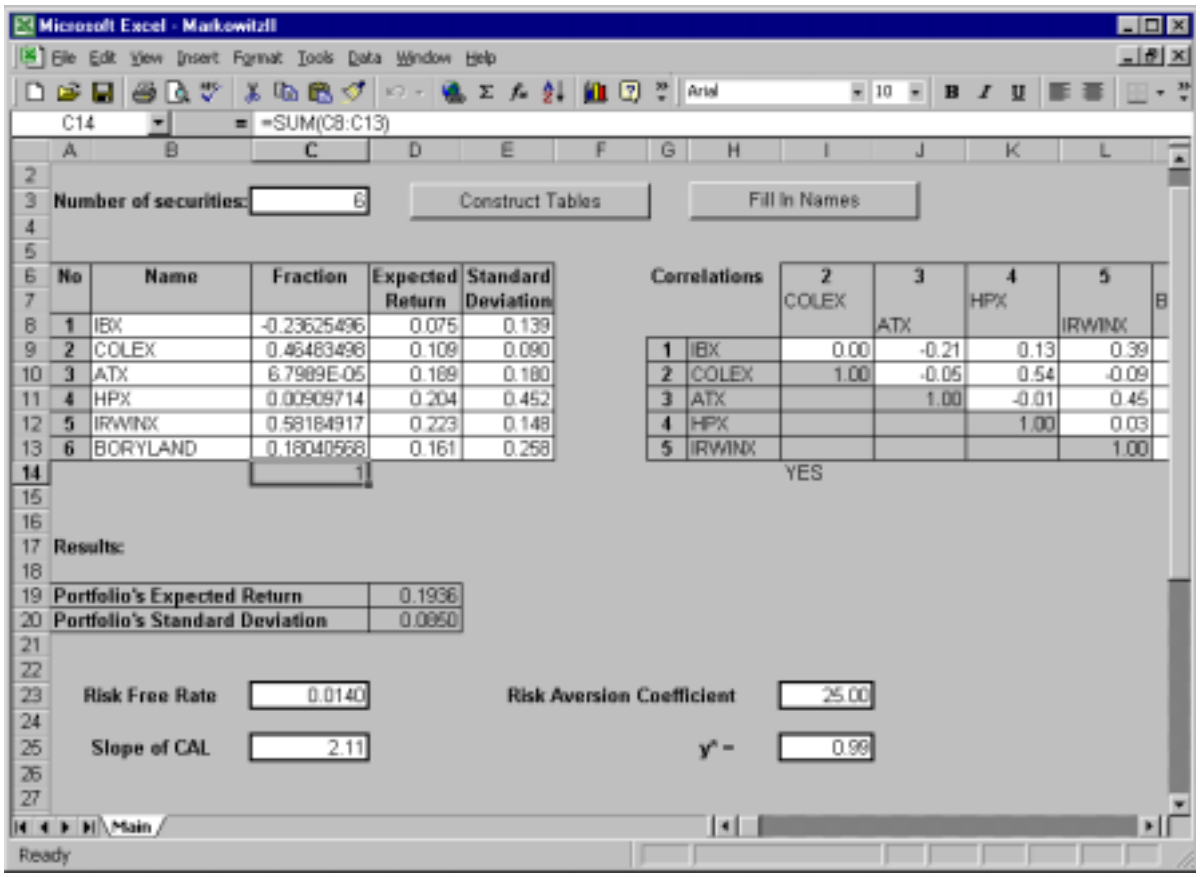


[2] You can add other constraints such as "the weight of each asset is at least 5%" and "all the weights are non-negative".

3A.5. To keep the results, **press** the button **OK.**



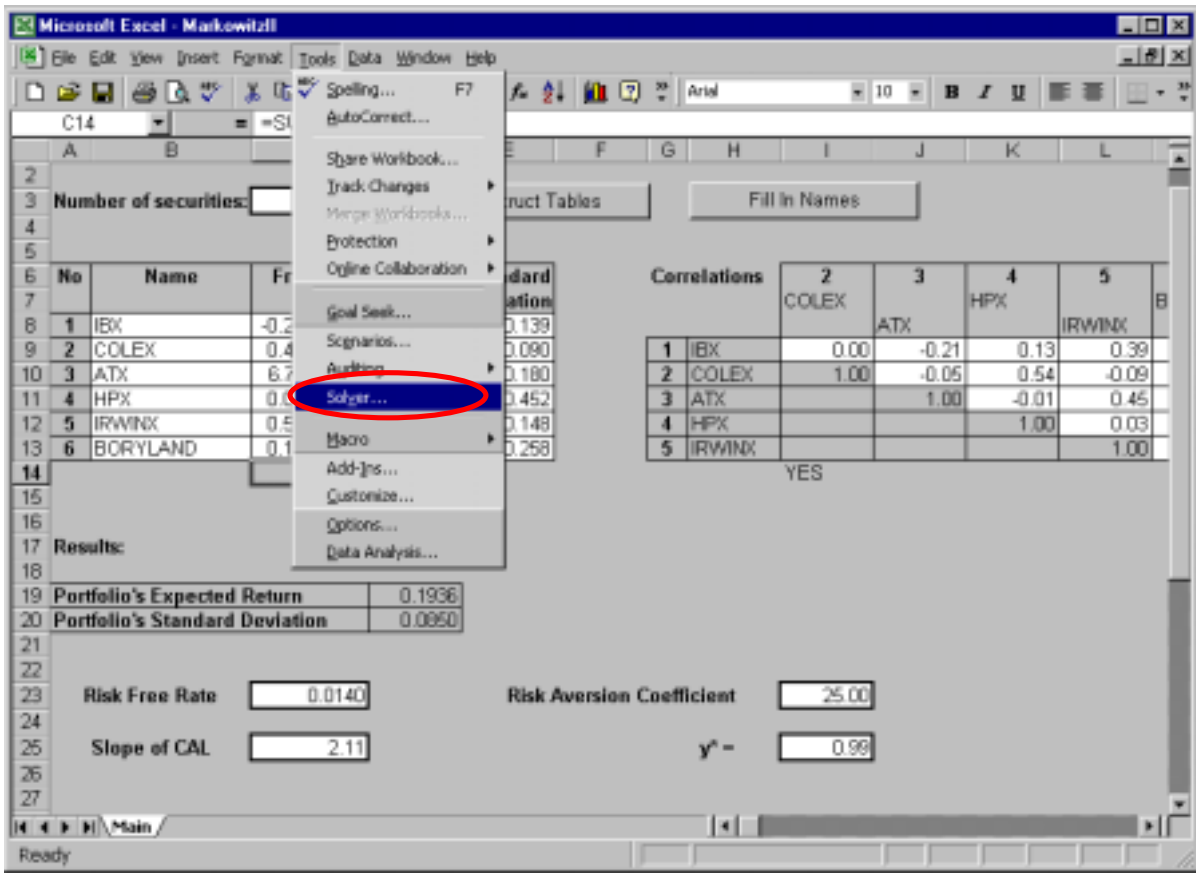
The optimal portfolio is given in $C$8:$C$13 and the corresponding expected return in $D$19.



Note that the weight for ATX is practically zero, 6.7989E-05 = .000067989.

3B. The lowest standard deviation for a given rate of expected return

3B.1. Click Tools on the menu bar and **choose Solver …**

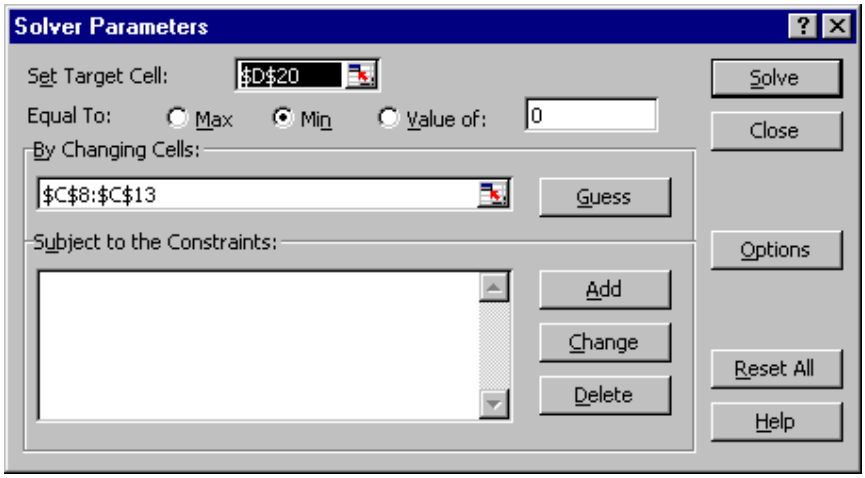


3B.2. In the Solver Parameters window, you ask the solver to minimize the portfolio's standard deviation:

Set Target Cell: $D$20 the cell recording the portfolio's expected return

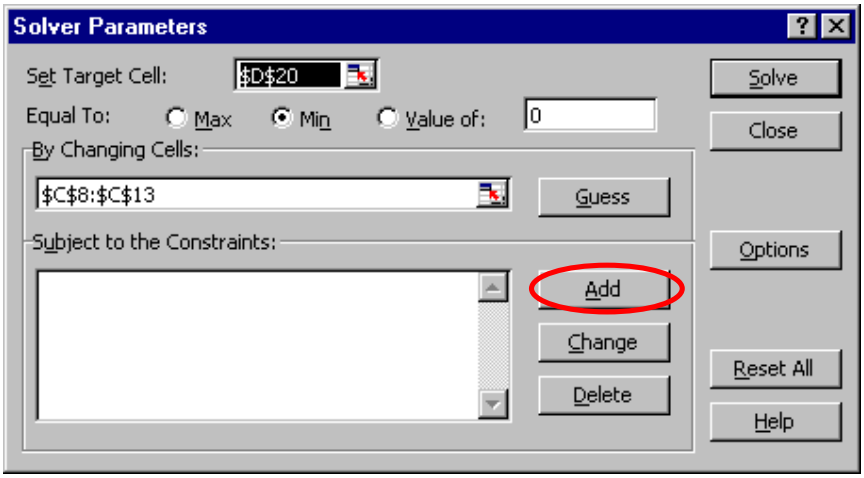
Equal To: ⊙ Min

By Changing Cells: $C$8:$C$13 the cells recording the weights or the fractions of the 6 assets.



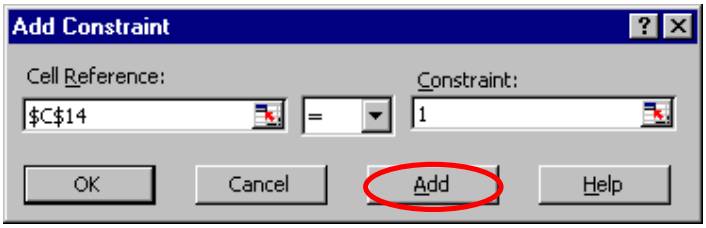
Suppose that you want the portfolio's expected return to be at least 20%.

3B.3. You have to tell the Solver this by **adding constraints (do not forget to delete constraints that may be there already if you are not going to need them).**



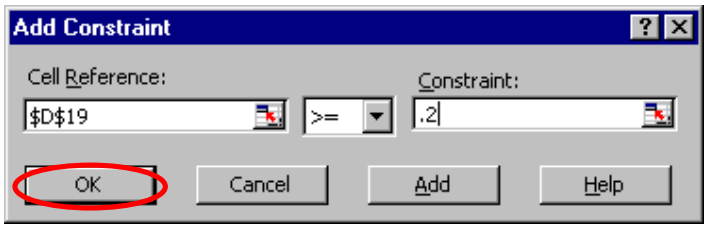
Constraint 1: **$C$14** the cell recording the sum of the weights (=sum($C$8:$C$13)) equals (=) **1**.

Press the button **Add** to add the second constraint.

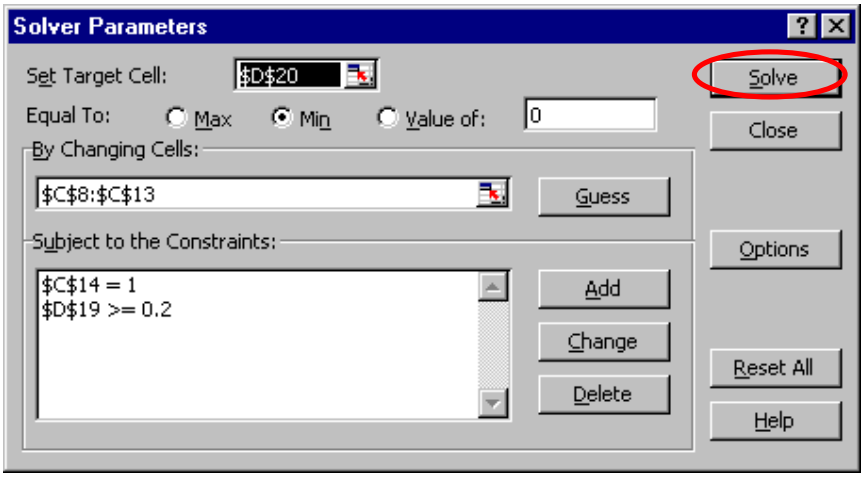


Constraint 2: $D$19 the cell recording the portfolio's expected return **is at least** (=>) **0.2**.

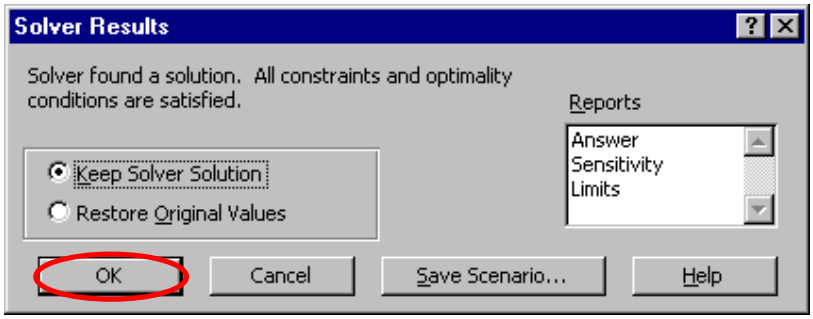
Press the button **OK** to return to the Solver Parameters window.



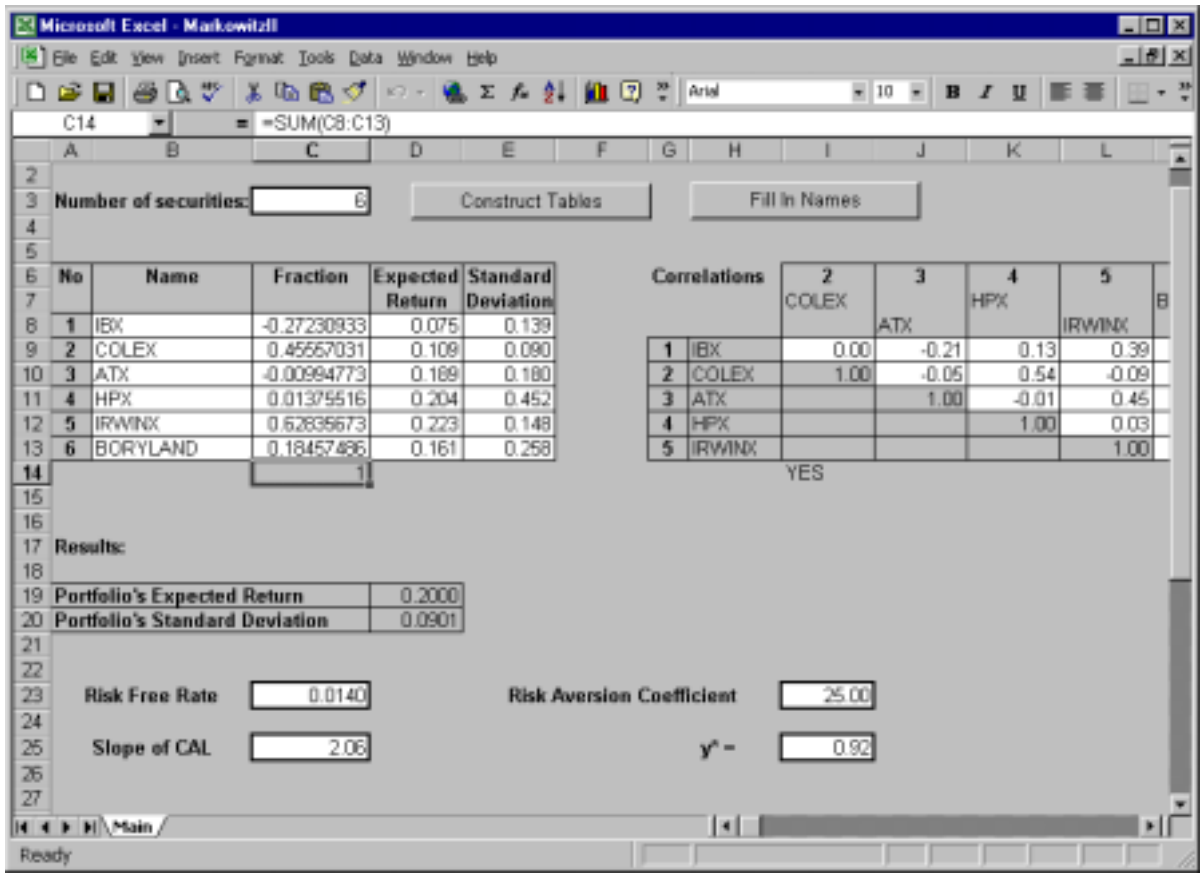
3B.4. The following window will appear. **Press** the button **Solve** to obtain the desired optimal portfolio.



3B.5. To keep the results, **press** the button **OK.**

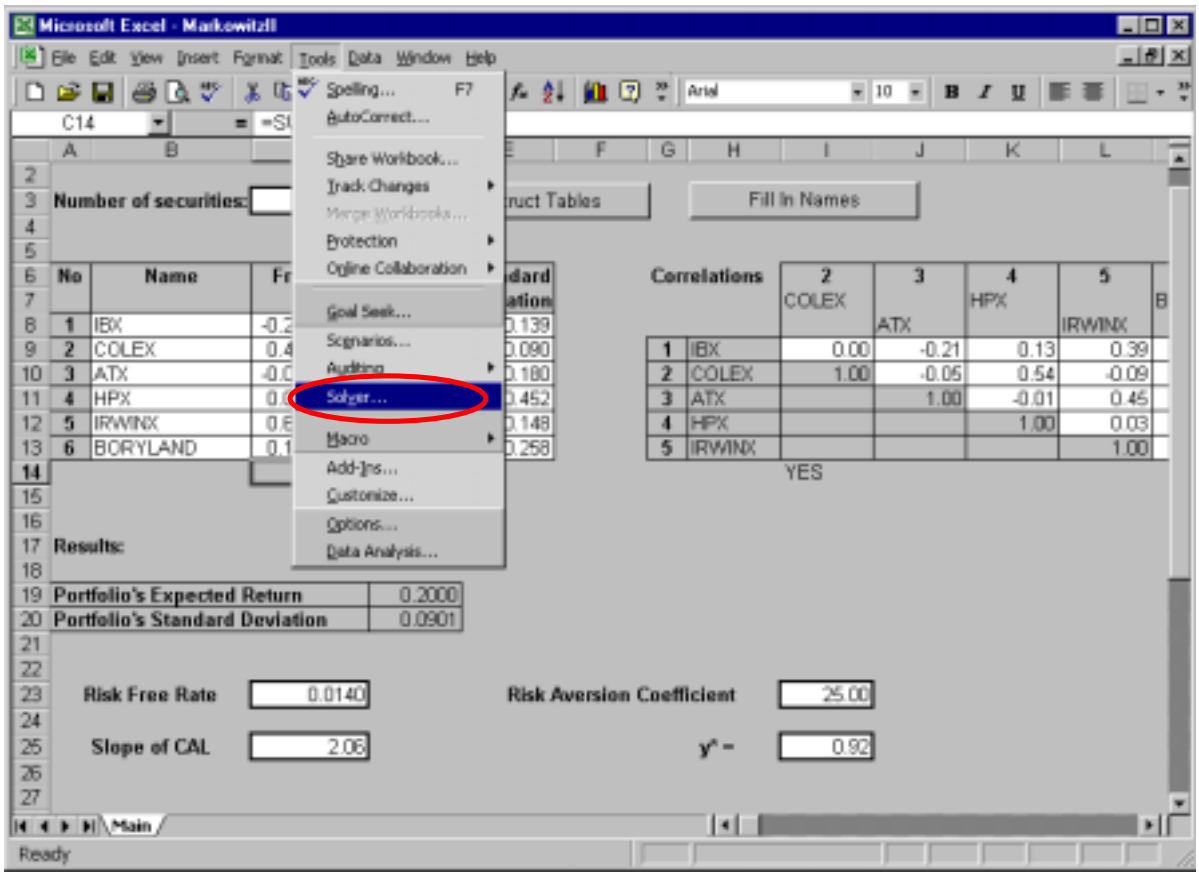


The optimal portfolio is given in $C$8:$C$13 and the corresponding standard deviation in $D$20.



3C. The highest reward-to-variability portfolio & the optimal portfolio for a given level of risk aversion.

3C.1. Click Tools on the menu bar and **choose Solver …**

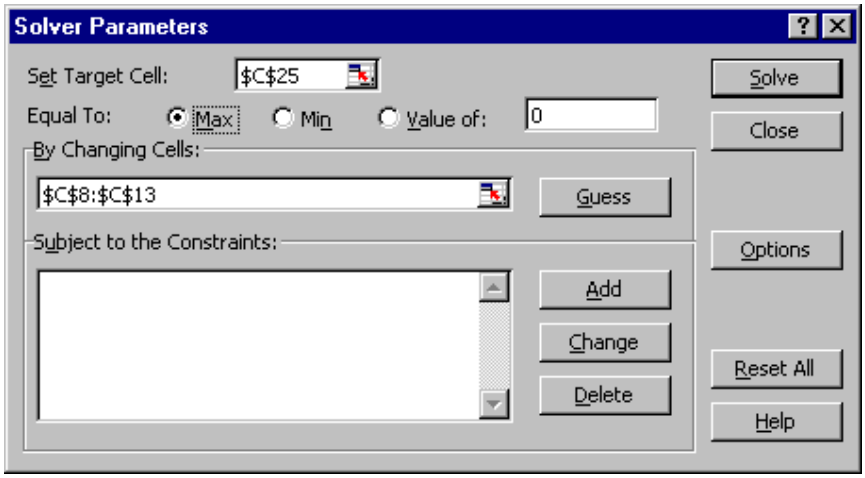


3C.2. In the Solver Parameters window, you choose "maximize" to find the portfolio that has the steepest capital allocation line CAL -- i.e., maximize the reward-to-variability ratio.

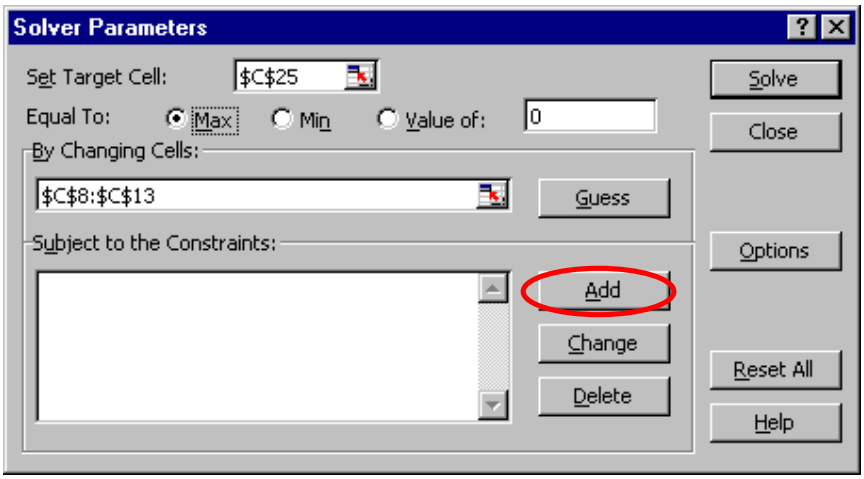
Set Target Cell: $C$25 the cell recording the slope of CAL

Equal To: ⊙ Max

By Changing Cells: $C$8:$C$13 the cells containing the weights for the 6 assets.

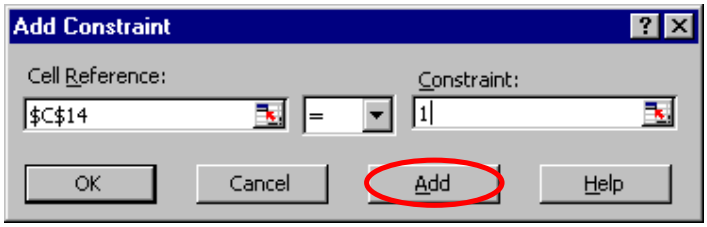


3C.3. You have to provide the Solver with the constraints by **adding constraints (do not forget to delete constraints that may be there already if you are not going to need them).**



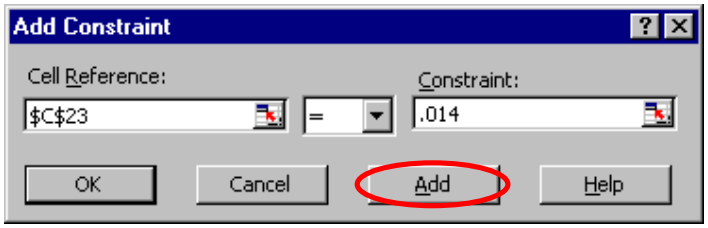
Constraint 1: **$C$14** the cell recording the sum of the weights (=sum($C$8:$C$13)) equals (=) **1**.

Press the button **Add** to add another parameter.



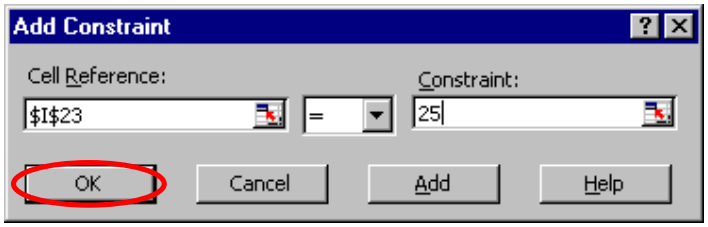
Constraint 2: **$C$23** the cell recording the risk-free rate **equals** (=) **0.014**.

Press the button **Add** to add the third constraint (another parameter).

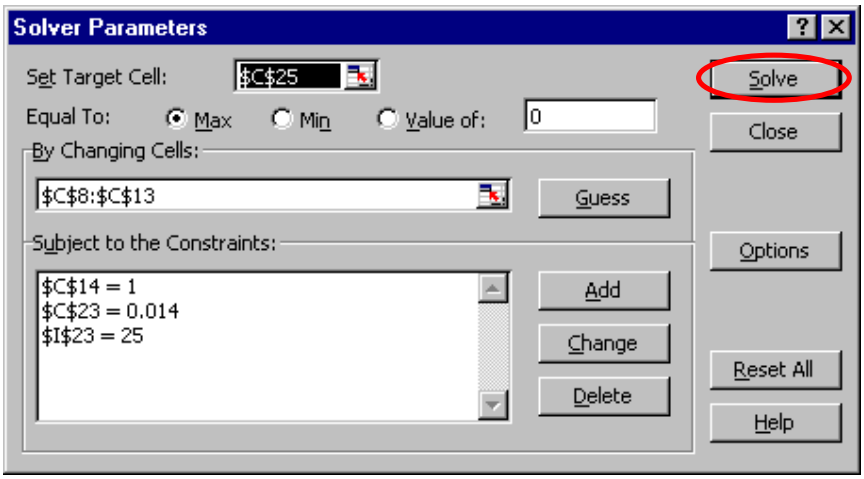


Constraint 3: **$C$23** the cell recording the risk aversion coefficient **equals** (=) **25**.

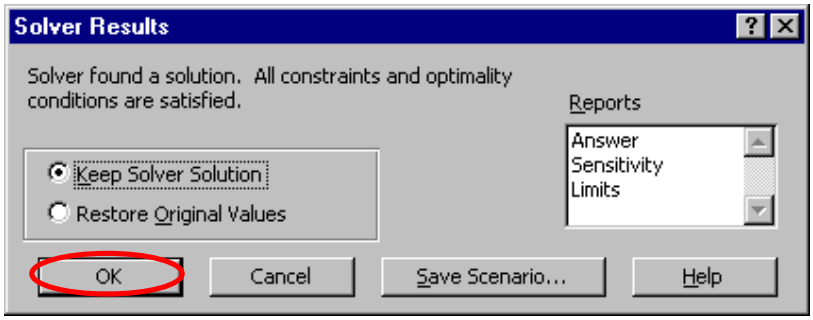
Press the button **OK** to return to the Solver Parameters window.



3C.4. The following window will appear. **Press** the button **Solve** to obtain the desired optimal portfolio.

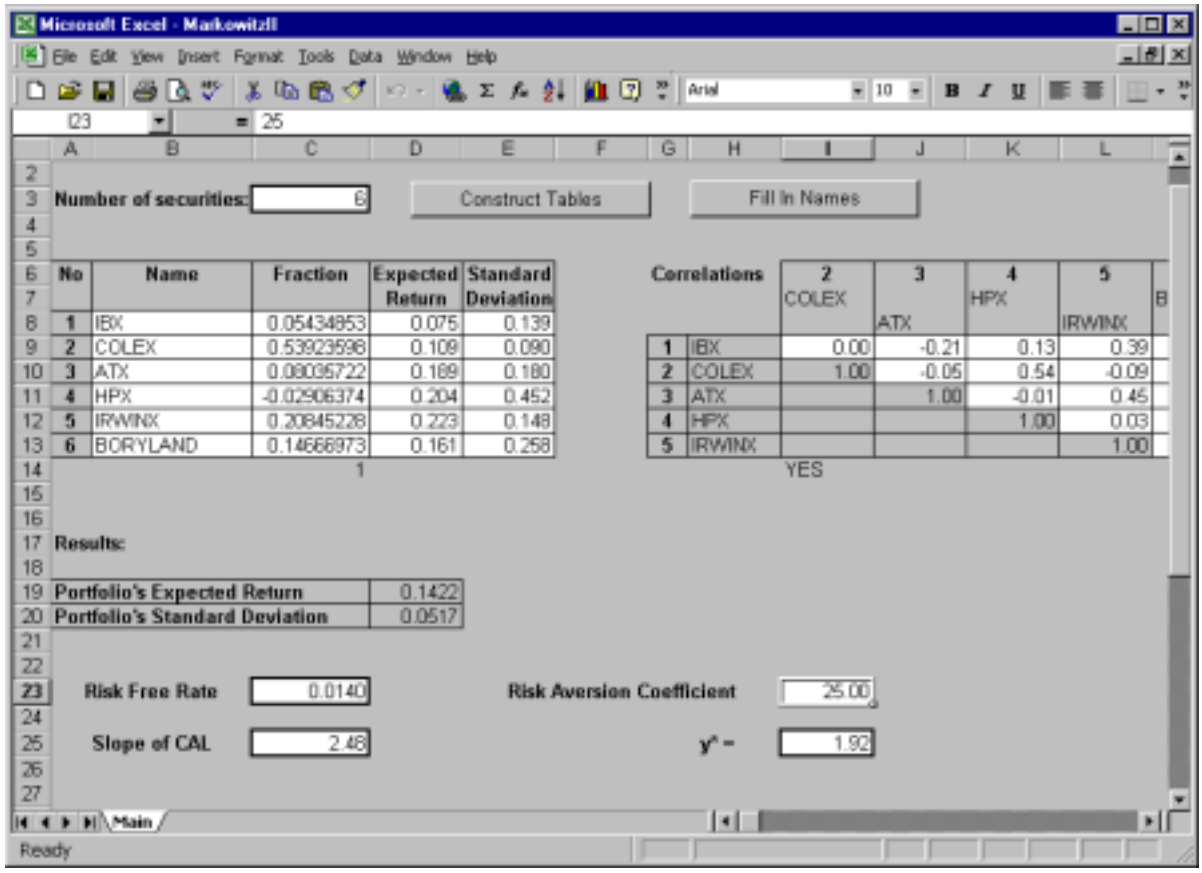


3C.5. To keep the results, **press** the button **OK.**



Note on Using Excel to Compute Optimal Risky Portfolios

The optimal risky portfolio is given in $C$8:$C$13 and the corresponding expected return and standard deviation in $D$19 and $D$20 whereas the optimal weight on the tangency portfolio is given in $I$25 for the risk aversion coefficient of 25.



3C.6. You can also study how the optimal weight for the risky assets and the slope of CAL change with the risk-free rate or the risk aversion coefficient. For instance, **increase** the risk-free rate to **0.05**, the optimal weight on the risky assets recording in the cell $I$25 immediately decreases from 1.92 to 1.38 and the slope of CAL recording in the cell $C$25 drops from 2.48 to 1.78.