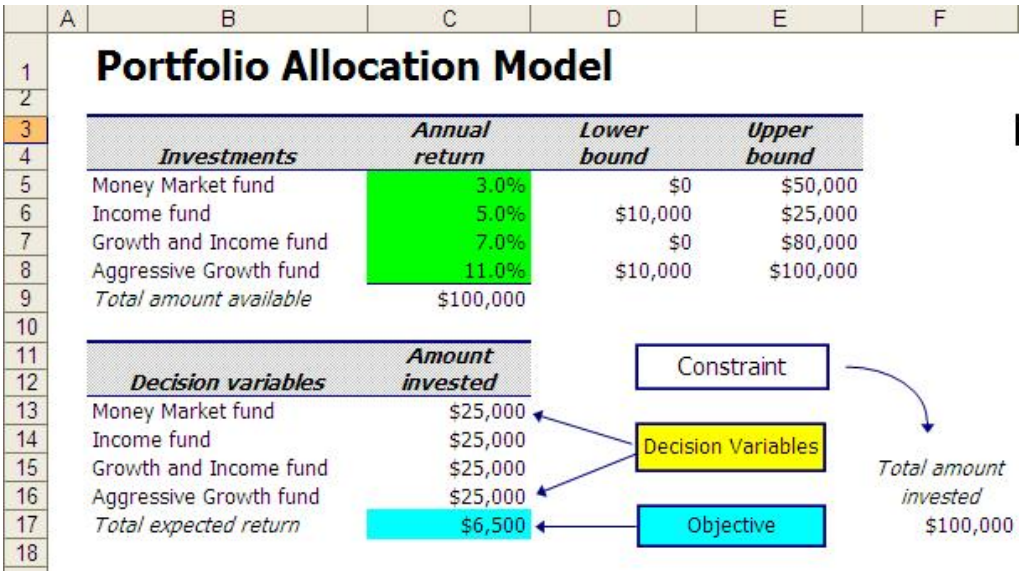
One-Minute Spotlight

How to Correlate Dependent Assumptions

In Crystal Ball, probability distributions (referred to as "assumptions") are usually calculated independently of each other. Crystal Ball generates random numbers for each assumption without regard to how random numbers are generated for other assumptions.

However, because dependencies often do exist between variables in a system being modeled, Crystal Ball has a Correlated Assumptions feature that lets you build these dependencies into your model. When the values of two variables depend on each other in any way, you should correlate them to increase the accuracy of your simulation's forecast results.



In the simple planning model above, the Crystal Ball assumptions are the Annual returns for the four investments (in green). While each investment's Annual return is uncertain, these assumptions are not independent because they share similar market influences.

What is Correlation in Crystal Ball?

Correlation is defined through the assumption definition dialog. Crystal Ball correlates pairs of assumptions using a **correlation coefficient**, which measures the strength of the relationship between the pair.

On a scale of -1 to 1, coefficients can be positive (0 to 1), where they increase or decrease in the same direction, or negative (0 to -1), where one increases while the other decreases. The closer you are to -1 to 1, the stronger the relationship.

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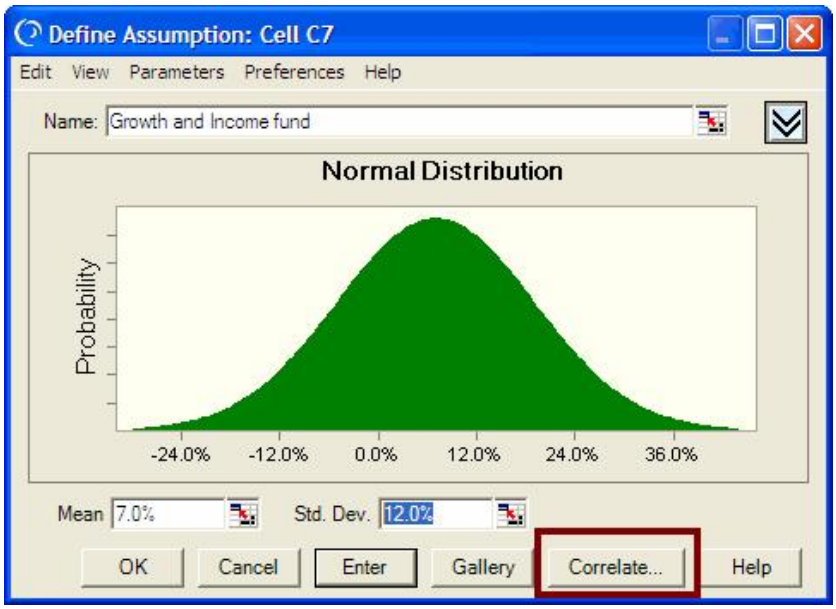
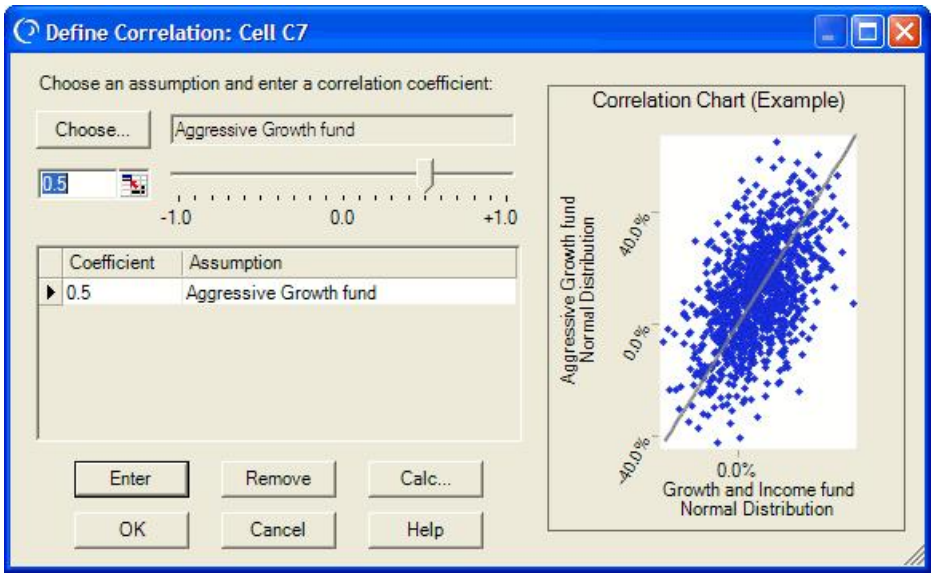


In this example, you know that the Growth and Income Fund and the Aggressive Growth Fund share some common market influences, and that they have a positive relationship (0.5). In either of the assumptions, you can define the correlation by selecting the Correlate button at the bottom right of the dialog box.

Defining the Correlations



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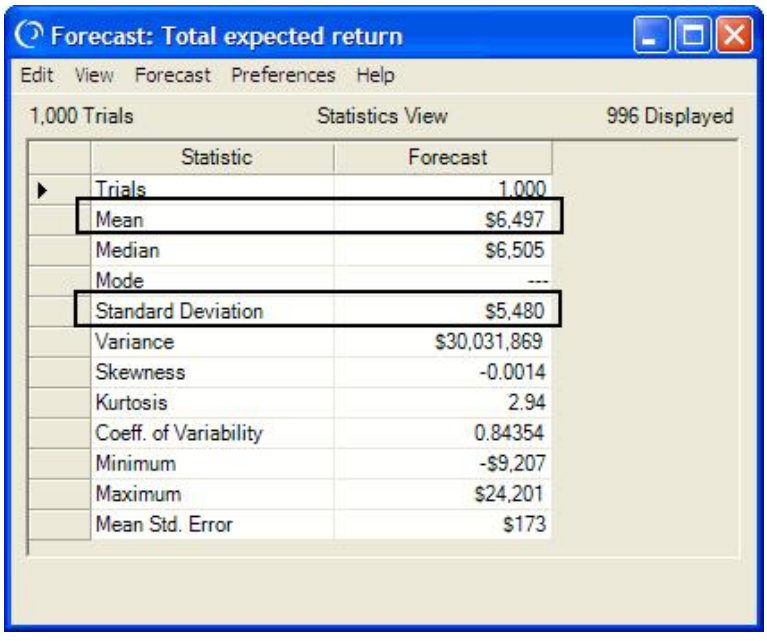
To correlate the two funds, you select Aggressive Growth from the list at the top center of this dialog (cell C8 of the spreadsheet), enter 0.5 in the field below the assumption location, and press Enter. Crystal Ball graphically depicts the relationship between the assumptions on the right.

You can correlate this fund to other assumptions, remove correlations, or even have Crystal Ball calculate the coefficient if you have two sets of raw data for the two assumptions. Selecting OK exits this dialog.

When you run a simulation with correlation, Crystal Ball does not alter the way that the random values are generated for each assumption. It merely rearranges the values to produce the desired correlation. In this way, the original distributions of the assumptions are preserved.

Comparing the Uncorrelated and Correlated Results

When Crystal Ball ran 1000 simulations without correlation, the results for the Total expected return were as follows:



Statistic	Forecast
Trials	1,000
Mean	$6,497
Median	$6,505
Mode	---
Standard Deviation	$5,480
Variance	$30,031,869
Skewness	-0.0014
Kurtosis	2.94
Coeff. of Variability	0.84354
Minimum	-$9,207
Maximum	$24,201
Mean Std. Error	$173

Compare the above table with the results below, where correlation was used:

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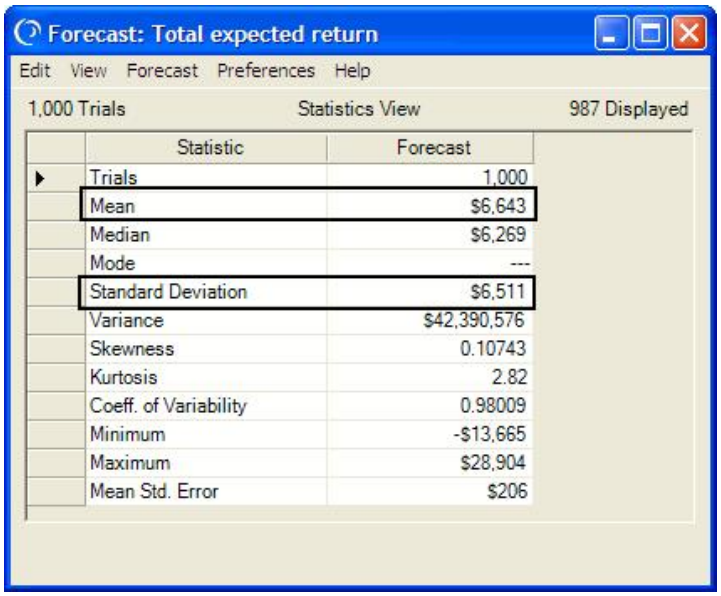

Statistic	Forecast
Trials	1,000
Mean	$6,643
Median	$6,269
Mode	---
Standard Deviation	$6,511
Variance	$42,390,576
Skewness	0.10743
Kurtosis	2.82
Coeff. of Variability	0.98009
Minimum	-$13,665
Maximum	$28,904
Mean Std. Error	$206

As you can see, the mean values are fairly close, but the standard deviation for the correlated simulation is much greater. This suggests that the true investment risk is greater than you would have suspected if you'd only run a simulation with independent assumptions. The correlations help you to create more realistic and accurate models.

Note: Some of the information in this Spotlight was taken from *Risk Analysis Using Crystal Ball,* our new Training CD.

For more information or to contact us, browse to http://www.crystalball.com