

One-Minute Spotlight

HOW TO CORRELATE DEPENDENT ASSUMPTIONS

In Oracle 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.

The screenshot shows a spreadsheet titled "Portfolio Allocation Model" with columns A through J and rows 1 through 21. The spreadsheet is divided into two main sections: "Investments" and "Decision variables".

Investments	Annual return	Lower bound	Upper bound
Money Market fund	3.0%	\$0	\$50,000
Income fund	5.0%	\$10,000	\$25,000
Growth and Income fund	7.0%	\$0	\$80,000
Aggressive Growth fund	11.0%	\$10,000	\$100,000
Total amount available	\$100,000		

Decision variables	Amount invested
Money Market fund	\$25,000
Income fund	\$25,000
Growth and Income fund	\$25,000
Aggressive Growth fund	\$25,000
Total expected return	\$6,500

Callouts in the image:

- "Funding constraint" points to the "Total amount available" cell (\$100,000).
- "Decision variables" points to the "Amount invested" column for the four funds.
- "Maximize return" points to the "Total expected return" cell (\$6,500).

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.

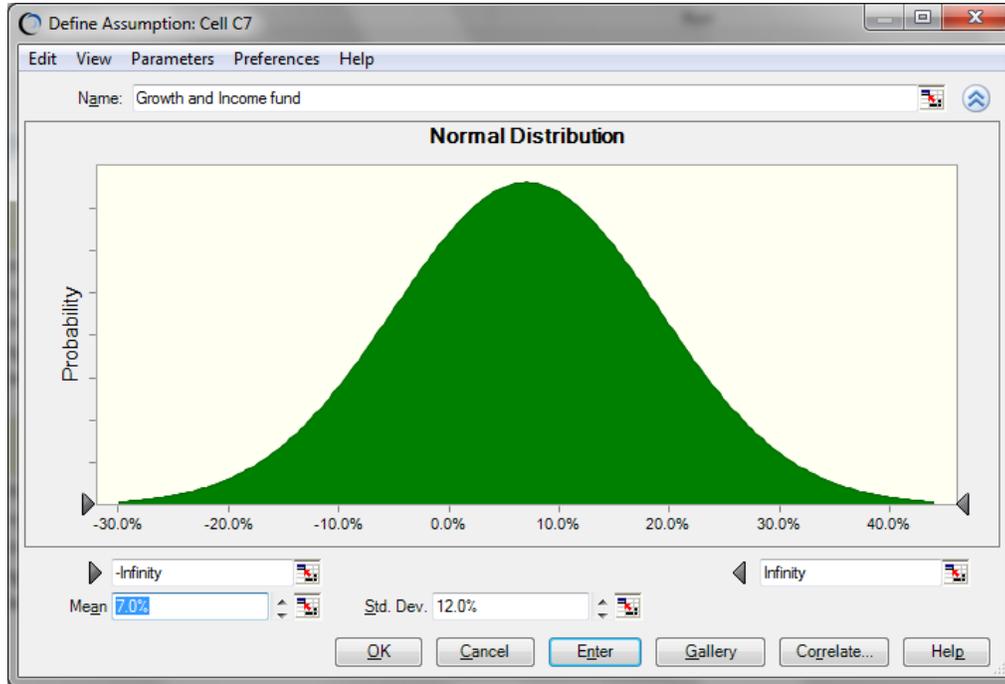
WHAT IS CORRELATION IN CRYSTAL BALL?

Correlation is defined through the Define Assumptions 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.

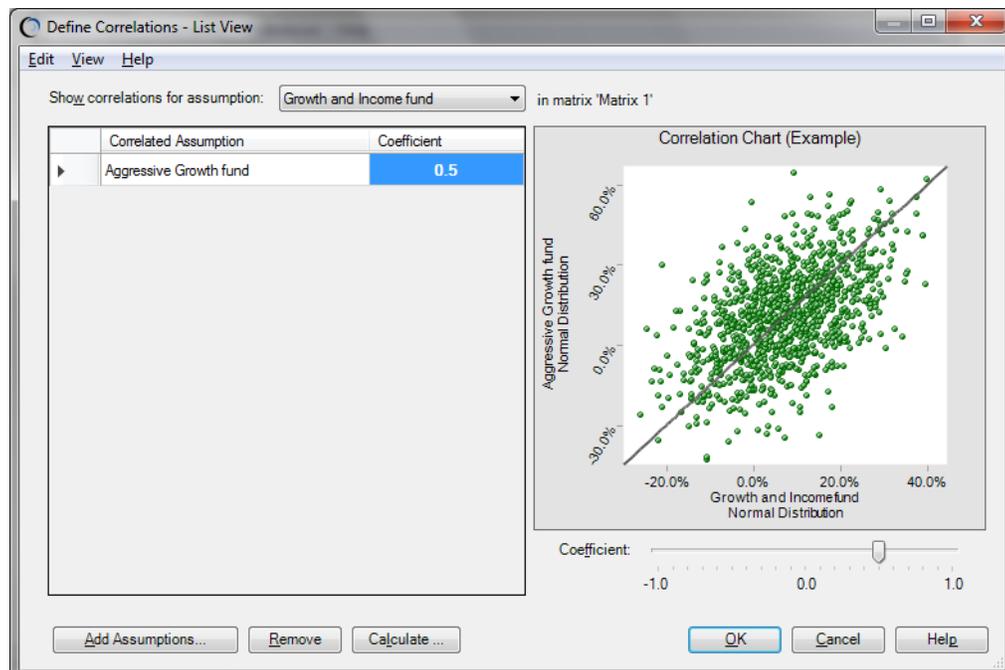
Correlating Assumptions, continued

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

The current assumption, Growth and Income Fund, displays in the box at the top of the window.



Correlating Assumptions, continued

To define the correlation, click Add Assumptions, and then select Aggressive Growth Fund. When you click OK, Aggressive Growth Fund is added to the correlation list. As shown in the previous picture, when you enter 0.5 in the Coefficient field and click OK, Crystal Ball graphically depicts the relationship between the assumptions in the right panel.

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

Run Preferences were set so that 1000 simulation trials were run using Monte Carlo simulation with a seed value of 999. The results for the Total Expected Return were as follows (first table):

Statistic	Forecast values
Trials	1,000
Base Case	\$6,500
Mean	\$6,606
Median	\$6,628
Mode	---
Standard Deviation	\$5,445
Variance	\$29,648,481
Skewness	-0.0362
Kurtosis	2.99
Coeff. of Variation	0.8243
Minimum	-\$11,010
Maximum	\$26,042
Mean Std. Error	\$172

Statistic	Forecast values
Trials	1,000
Base Case	\$6,500
Mean	\$6,740
Median	\$6,598
Mode	---
Standard Deviation	\$6,233
Variance	\$38,848,595
Skewness	-0.0508
Kurtosis	2.99
Coeff. of Variation	0.9248
Minimum	-\$21,713
Maximum	\$24,780
Mean Std. Error	\$197

Compare the first table with the results in the second table, where correlation was used.

As you can see, the mean values are fairly close, but the standard deviation and variance for the correlated simulation are 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.

For more information or to contact us, browse to

<http://www.oracle.com/technetwork/middleware/crystalball/overview/index.html>.