Cubic Spline Interpolation and Extrapolation

In This Issue

1. Discover the usefulness of spline curves.
2. Learn how to run ***Risk Simulator's*** Cubic Spline module.

"What do you do when there are missing values in a time-series dataset?"

Theory

Sometimes there are missing values in a time-series dataset. For instance, interest rates for years 1 to 3 may exist, followed by years 5 to 8, and then year 10. Spline curves can be used to interpolate the missing years' interest rate values based on the data that exist. Spline curves can also be used to forecast or extrapolate values of future time periods beyond the time period of available data. The data can be linear or nonlinear. Figure 1 illustrates how a cubic spline is run, and Figure 2 shows the resulting forecast report from this module. The Known *X* values represent the values on the *x*-axis of a chart (in our example, this is Years of the known interest rates, and, usually, the *x*-axis values are those that are known in advance such as time or years) and the Known *Y* values represent the values on the *y*-axis (in our case, the known Interest Rates). The *y*-axis variable is typically the variable you wish to interpolate missing values from or extrapolate the values into the future.

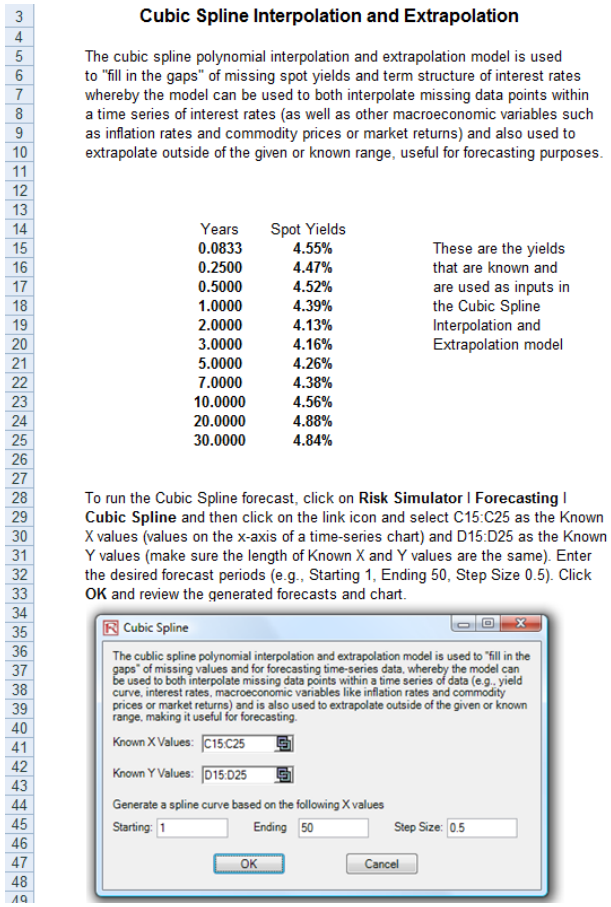

Figure 1. Cubic Spline Module

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Procedure

- Start Excel and open the example file *Advanced Forecasting Model*, go to the *Cubic Spline* worksheet, select the data set excluding the headers, and click on *Risk Simulator | Forecasting | Cubic Spline*.
- The data location is automatically inserted into the user interface if you first select the data, or you can also manually click on the link icon and link the *Known X* values and *Known Y* values (see Figure 1 for an example), then enter the required *Starting* and *Ending* values to extrapolate and interpolate, as well as the required *Step Size* between these starting and ending values. Click *OK* to run the model and report (see Figure 2).

Cubic Spline Forecasts

The cubic spline polynomial interpolation and extrapolation model is used to "fill in the gaps" of missing values and for forecasting time-series data, whereby the model can be used to both interpolate missing data points within a time series of data (e.g., yield curve, interest rates, macroeconomic variables like inflation rates and commodity prices or market returns) and also used to extrapolate outside of the given or known range, making it useful for forecasting.

Spline Interpolation and Extrapolation Results

X	Fitted Y	Notes
1.0	4.39%	Interpolate
1.5	4.21%	Interpolate
2.0	4.13%	Interpolate
2.5	4.13%	Interpolate
3.0	4.16%	Interpolate
3.5	4.19%	Interpolate
4.0	4.22%	Interpolate
4.5	4.24%	Interpolate
5.0	4.26%	Interpolate
5.5	4.29%	Interpolate
6.0	4.32%	Interpolate
6.5	4.35%	Interpolate
7.0	4.38%	Interpolate
7.5	4.41%	Interpolate
8.0	4.44%	Interpolate
8.5	4.47%	Interpolate
9.0	4.50%	Interpolate
9.5	4.53%	Interpolate
10.0	4.56%	Interpolate
10.5	4.59%	Interpolate

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These are the known value inputs in the Cublic Spline Interpolation and Extrapolation model:

Observation	Known X	Known Y
1	0.0833	4.55%
2	0.2500	4.47%
3	0.5000	4.52%
4	1.0000	4.39%
5	2.0000	4.13%
6	3.0000	4.16%
7	5.0000	4.26%
8	7.0000	4.38%
9	10.0000	4.56%
10	20.0000	4.88%
11	30.0000	4.84%

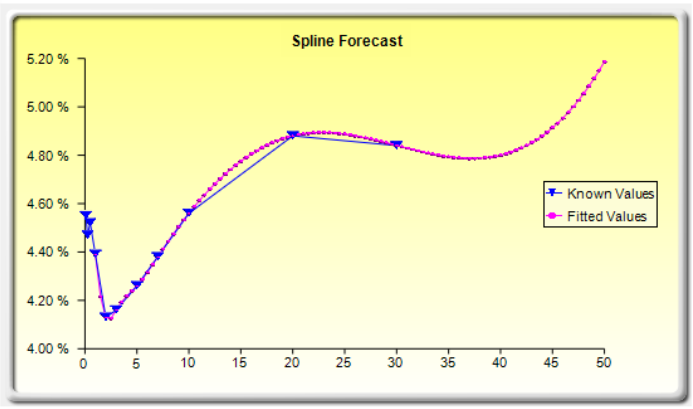

Figure 2. Spline Forecast Results

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