

In This Issue

1. Discover how sensitivity analysis contrasts with tornado analysis
2. Learn when and how to run a sensitivity analysis

“How can you identify the impact to the results when multiple interacting variables are simulated together in a model?”

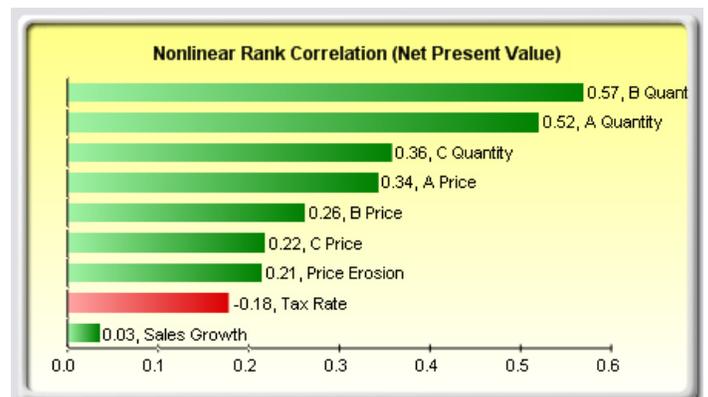
Theory

A powerful feature in *Risk Simulator* is sensitivity analysis. While tornado analysis (tornado charts and spider charts) applies static perturbations *before* a simulation run, sensitivity analysis applies dynamic perturbations created *after* the simulation run. Tornado and spider charts are the results of static perturbations, meaning that each precedent or assumption variable is perturbed a preset amount one at a time, and the fluctuations in the results are tabulated. In contrast, sensitivity charts are the results of dynamic perturbations in the sense that multiple assumptions are perturbed simultaneously, and their interactions in the model and correlations among variables are captured in the fluctuations of the results. Tornado charts therefore identify which variables drive the results the most and, hence, are suitable for simulation. In contrast, sensitivity charts identify the impact to the results when multiple interacting variables are simulated together in the model. This effect is clearly illustrated in Figure 1. Notice that the ranking of critical success drivers is similar to tornado analysis. However, if correlations are added between the assumptions, Figure 2 shows a very different picture. Notice for instance, price erosion had little impact on NPV, but when some of the input assumptions are correlated, the interaction that exists between these correlated variables makes price erosion have more impact. Note that tornado analysis cannot capture these correlated dynamic relationships. Only after a simulation is run will such relationships become evident in a sensitivity analysis. A tornado chart’s presimulation critical success factors will therefore sometimes be different from a sensitivity chart’s postsimulation critical success factor. The postsimulation critical success factors should be the ones that are of interest as these more readily capture the model precedents’ interactions.



Figure 1. Sensitivity Chart without Correlations

Figure 2. Sensitivity Chart with Correlations



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Results Interpretation

The results of the sensitivity analysis comprise a report and two key charts. The first is a nonlinear rank correlation chart (Figure 4) that ranks from highest to lowest the assumption-forecast correlation pairs. These correlations are nonlinear and nonparametric, making them free of any distributional requirements (i.e., an assumption with a Weibull distribution can be compared to another with a Beta distribution). The results from this chart are fairly similar to tornado analysis (of course, without the capital investment value, which we decided was a known value and, hence, was not simulated), with one special exception. Tax rate was relegated to a much lower position in the sensitivity analysis chart (Figure 4) as compared to a tornado chart. This is because by itself, tax rate will have a significant impact, but once the other variables are interacting in the model, it appears that tax rate has less of a dominant effect (this is because tax rate has a smaller distribution as historical tax rates tend not to fluctuate too much, and also because tax rate is a straight percentage value of the income before taxes, where other precedent variables have a larger effect on NPV). This example proves that performing sensitivity analysis after a simulation run is important to ascertain if there are any interactions in the model and if the effects of certain variables still hold. The second chart (Figure 5) illustrates the percent variation explained; that is, of the fluctuations in the forecast, how much of the variation can be explained by each of the assumptions after accounting for all the interactions among variables? Notice that the sum of all variations explained is usually close to 100% (sometimes other elements impact the model but they cannot be captured here directly), and if correlations exist, the sum may sometimes exceed 100% (due to the interaction effects that are cumulative).

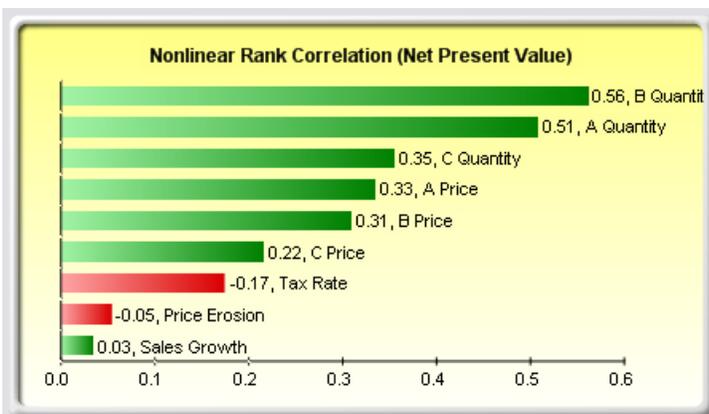
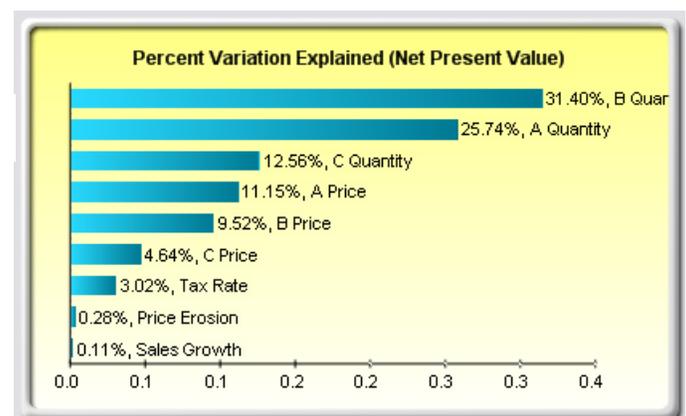


Figure 4. Rank Correlation Chart

Figure 5. Contribution to Variance Chart



Notes

Tornado analysis is performed before a simulation run while sensitivity analysis is performed after a simulation run. Spider charts in tornado analysis can consider nonlinearities while rank correlation charts in sensitivity analysis can account for nonlinear and distributional-free conditions.