Effective Communication of Stochastic Model Results

By John Hegstrom

One of the challenges facing financial modelers is how best to display a distribution of results. The goal is to convey the necessary information without making the recipient work too hard to understand it. Also, the viewer should be able to come to his or her own conclusion without being led to a specific outcome. Blending art with science helps develop an effective graphical presentation of a distribution of results. A fixed deferred annuity product with a market value adjustment was chosen as a test case for developing graphical displays of results. The results distribution consists of the present value of distributable earnings at issue from a group of new contracts. One thousand economic scenarios were run to produce the distribution of results. In addition, four product variations were compared.

There are many options for presentation of the results. At one extreme, a point estimate of the mean of the distribution could be communicated as a single number. At the other extreme, a complete table of results by economic scenario could be provided. Clearly, neither of these extremes would be appropriate for decision making. Several alternatives will be explored. The intention is to convey the nature of complex results in a simple-to-understand format.

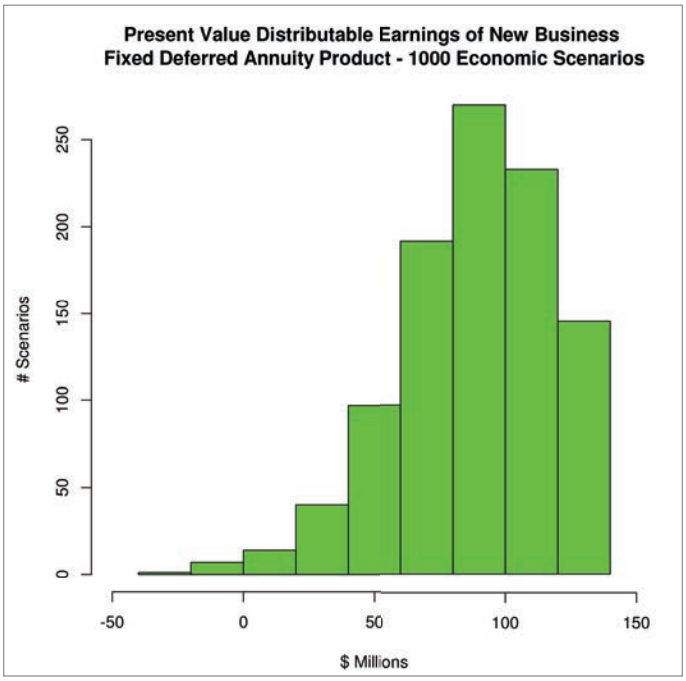
UNDERSTAND YOUR AUDIENCE

Understanding your audience is the first step in effective visual communication. Busy executives do not want to be overwhelmed with too much data in a graph or chart. On the other hand, they need enough information to make effective decisions. Technical audiences will want the ability to extract more details. Avoid jargon or acronyms that your audience may not understand. Know in advance if any of your audience is visually impaired with color blindness or other conditions, and make adjustments as necessary.

TYPES OF GRAPHS

There are a number of approaches to take when presenting graphical results. Following are some of these options, along with a brief description and example of each.

Figure 1
Histogram



Histogram

One of the most common approaches to display a distribution of results is a histogram. Figure 1 shows a basic histogram of the results from the base annuity product run.

Note that there are choices of bin size, coloring, scale and annotations, among others. The choice of bin size is important. If the bins are too large, important details about the distribution will be left out. If the bins are too small, the big picture will be obscured by the noise. Colors can have meaning or just aesthetic appeal. Annotations can provide valuable supplemental information to aid the viewer. One of the drawbacks of a histogram is that it is difficult to display multiple distributions side by side effectively.

Density Plot

Another graph related to the histogram is the density plot. Kernel density estimation (KDE) estimates the probability density function based on sample data. The curve will have the same shape as a histogram but will be a smooth representation of the data. Figure 2 shows a density plot (green line) overlaid on the previous histogram.

The density plot provides a good representation of the data. However, there are some parameters that need to be set, such as the smoothing kernel distribution and bandwidth. Most statistical packages do a good job of selecting optimal parameters, but the data should be compared to a histogram for reasonability.

Figure 2
Density Plot

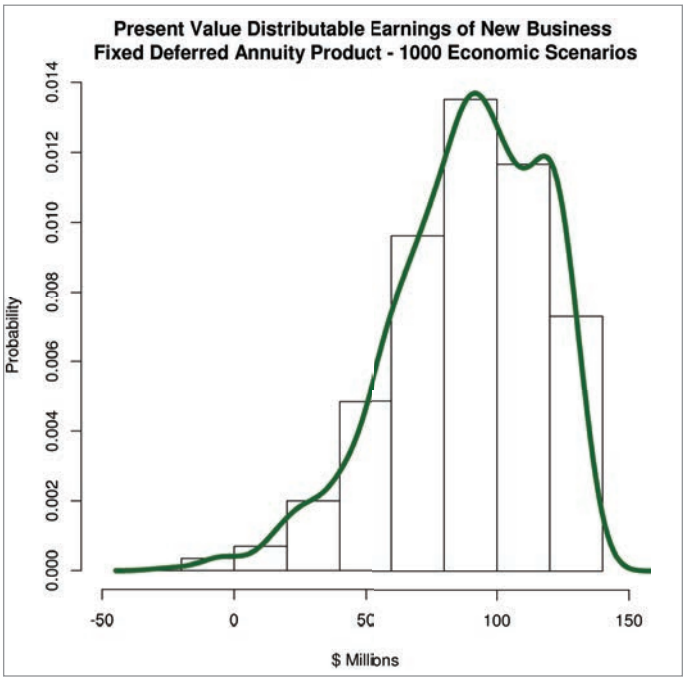


Figure 3
Strip Chart with Jitter

Several density plots can be overlaid using different colors to compare different sets of results. However, this can be confusing if different plots are somewhat similar.

Strip Chart With Jitter

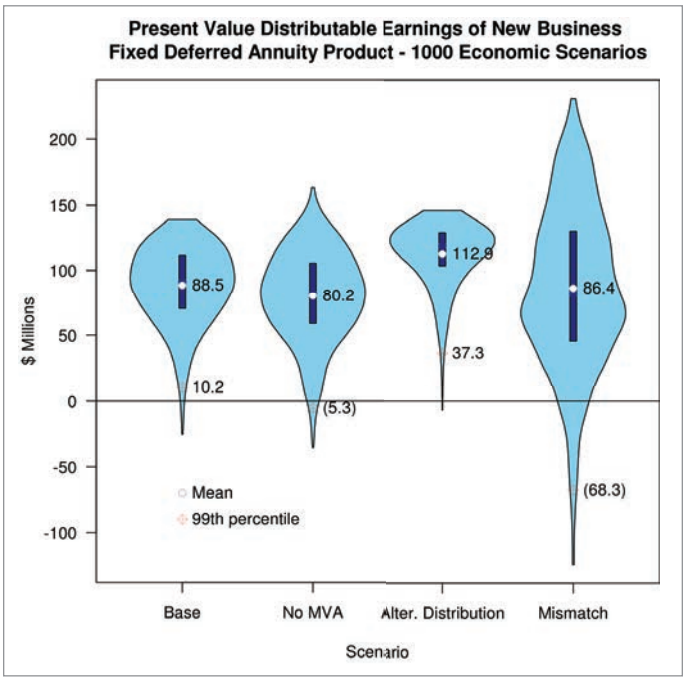
A strip chart can be created showing the distribution of data points. Normally, a strip chart shows data in one dimension. However, by adding jitter, which is controlled random noise, it becomes easier to see the distributional pattern. In addition, color can be added to the data points to provide valuable information, as in Figure 3.

In this strip chart, the data points are colored based on the relative level of interest rates over the modeling period. This provides valuable information to the viewer on an important factor that is driving results. The jittering takes place along the *x*-axis, providing some space between points. Strip charts can be shown with comparable data sets side by side, if desired.

Violin Plot

Violin plots are basically density plots shown in a symmetric fashion, allowing side-by-side visualization of comparable data. In addition, they typically show the quartiles and median of the data. The modified violin plot in Figure 4 shows the results of several variations of the product and the corresponding results distributions.

Figure 4
Violin Plot



The violin plot has been modified from the standard violin plot template in a few ways. First, the mean is shown instead of the

median, as the mean of the distribution has special significance as a probability weighted expected value, assuming that the economic scenarios are equally probable. Second, only the middle 50 percent of the data is indicated by the dark blue shapes; the standard whiskers have been removed for the sake of clarity. Third, the 99th percentile of the data is indicated by the red symbol and a label. This risk measure could easily be set to other measures, such as a conditional tail expectation (CTE) level or a value at risk (VaR) amount.

This modified violin plot has the advantage of being able to easily display results side by side, show the shape of the results distribution and show the key metrics as well. It is a valuable chart for presenting results to decision makers. Figure 4 leads to the conclusion that the alternative distribution strategy (lower excess lapse rates) offers a superior risk/reward profile and should be pursued if viable. Another conclusion is that stretching the asset duration to pick up yield does not pay off in this instance and increases risk.

ASOP 41

Graphs can be considered a part of actuarial communications and a component of an actuarial report under Actuarial Standard of Practice (ASOP) 41. It is necessary to follow ASOP 41 when creating, presenting and distributing graphs, if it applies. ASOP 41 lays down requirements as to form, content and disclosures. Proper disclosure of methodology and assumptions is required. It is important to disclose that the distributions shown are just estimates and don't encompass all possibilities.

CONCLUSION

With today's computing power, large numbers of scenarios can be run. The resulting avalanche of results data needs to be analyzed and communicated in an efficient and effective manner. There are many powerful tools, such as violin plots and strip charts (with jitter), that can be successfully used to analyze and communicate results.

The visual displays in this article were created using the freely available R software package. The annuity product used in the examples resembles real-world products but is fictitious. ■

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