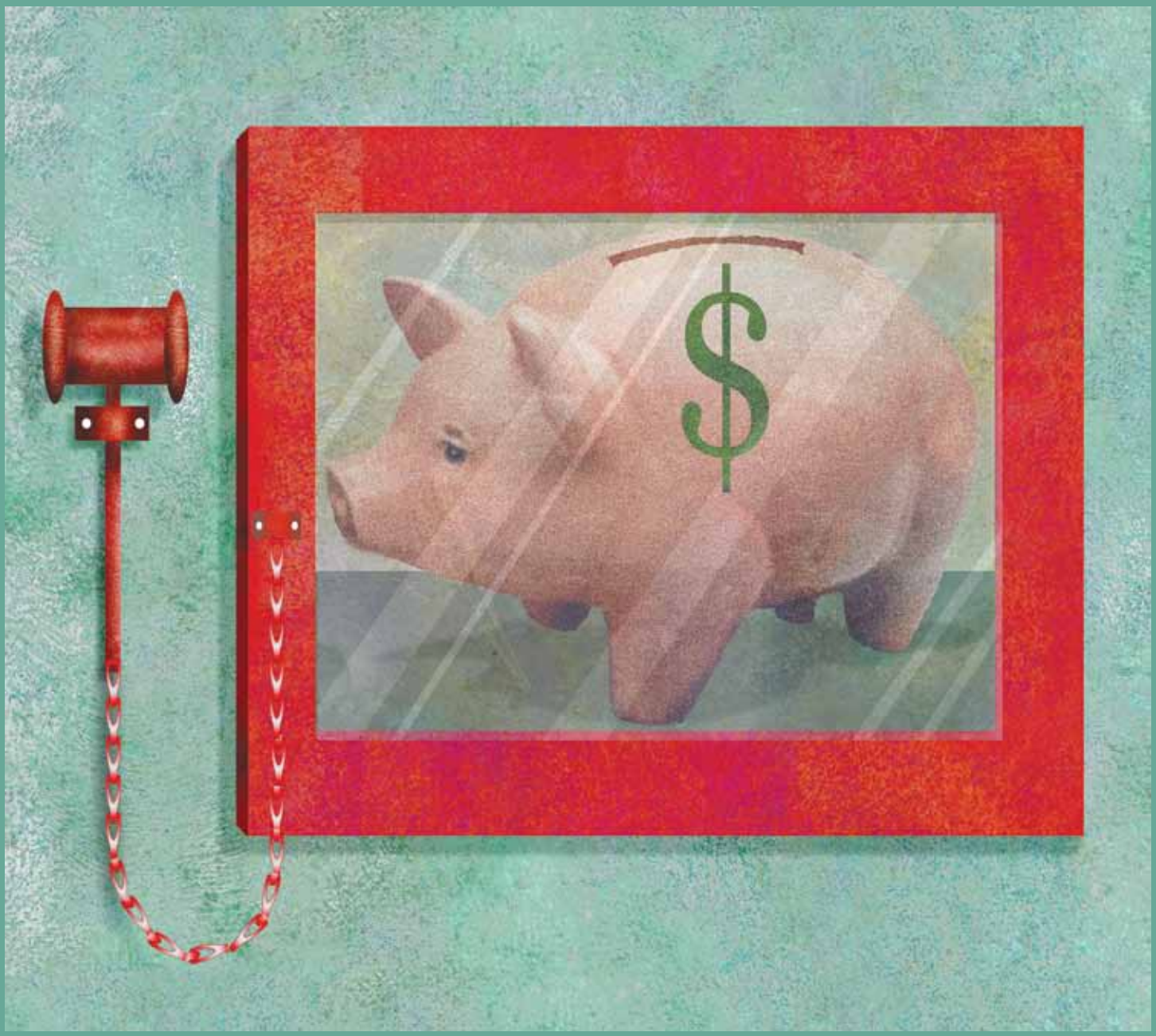

STRESS TESTING

Your Reserves with Advanced Analytical Techniques

BY SHAYNE KAVANAGH

Financial reserves, or "rainy day" funds, safeguard local governments against budget-straining risks like recessions or extreme events that demand a quick and decisive public safety response. The perennial question local governments have about reserves is how much is enough. Too little and you may be underprepared for the risks you face, but too much may mean you're overtaxing the public or failing to make investments in needed infrastructure or services.

GFOA recommends maintaining general fund reserves equal to two months of operating revenue — or, put another way, equal to 16.7 percent of annual revenue. However, this is just a rule of thumb, and each local government needs to decide the right amount for itself. For example, a smaller local government that relies on sales taxes (which are often vulnerable to economic downturns) and is at risk for experiencing a number of potential natural disasters would need relatively more reserves than a larger government that is reliant on property taxes (which are usually fairly stable, despite economic downturns) and is subject to fewer natural disasters.

GFOA recommends maintaining general fund reserves equal to two months of operating revenue — or, put another way, equal to 16.7 percent of annual revenue.

TRYING TO UNDERSTAND RISK

The way to decide the appropriate amount for your local government is to better understand your risks. Risk can be defined as the probability and magnitude of a loss, disaster, or other undesirable event.[1] To understand risks, you need to quantify them. Peter Bernstein, author of *Against the Gods: The Remarkable Story of Risk*, makes a good case for why we need to quantify risk:

> *"Without numbers, there are no odds and no probabilities; without odds and probabilities, the only way to deal with risk is to appeal to the gods and the fates. Without numbers, risk is wholly a matter of gut."*

Most human beings are terrible judges of odds and probabilities, making gut feelings a terrible way to judge risk. For example, researchers have found that people are generally overconfident in their ability to predict the future. This leads us to underestimate the range of possibilities we face. In fact, research has shown that human judgment generates a 50 percent smaller range of possibilities, compared to the range a statistical formula produces. GFOA recently had the chance to test this with a local government that was at risk for wildfires. The association asked the local fire department to estimate the magnitude of potential fires, and we compared its estimate to data on actual fires that had occurred in the region. The range from the fire department was almost exactly 50 percent smaller than the range suggested by the data we had gathered.

Another persistent flaw in people's reasoning about risk is tending to over-rely on recent experiences because they are able to more easily recall them. The classic example is flood insurance, which people buy after a flood occurs — but after a few years, many of those people will have let their insurance lapse, even though the underlying risk of a flood has not changed at all.

It isn't just people's reasoning about risk that impedes a proper understanding of it. Common analytical tools may actually lead to worse decision-making about risk. Perhaps the best example is the average, which summarizes an array of data into one convenient number. However, the average obscures the variation in the data. Variation is a source of uncertainty, and understanding uncertainty is key to understanding risk.

An old statistics joke illuminates the potential of this "flaw of averages"[2] to mislead: "In a room of ten people, if one of those people is Bill Gates, the average person is a millionaire." It is technically true that adding up the wealth of all ten people and dividing the resulting figure by ten would yield an amount of more than $1 million, and that is not a good description of the actual distribution of wealth. Similarly, the "average" earthquake, flood, or wildfire doesn't describe the distribution of risk well because it obscures the more extreme occurrences of these events — and the more extreme events, of course, are of great concern to a local government.

TRIPLE-A

How can a local government go about getting a better understanding of the risk it carries and the size of reserve it should have? In its work with local governments, GFOA uses

the "Triple-A" approach to uncertainty: accept, assess, and augment.[3]

> The way to decide the appropriate amount for your local government is to better understand your risks.

Accept. Uncertainty is inevitable, and people are generally overconfident in their ability to predict the future while underestimating uncertainty. Therefore, the first part of the Triple-A method is to accept that we are subject to uncertainty and to broaden our expectations for what could occur. For example, another recession will eventually occur. The Great Recession was of historic magnitude, but we should not assume that is the worst possible recession we could experience. Many economists think that the downturn could have been far worse if the federal government hadn't intervened as it did. Few people would argue that political parties have become more effective since 2007, so it is not difficult to imagine them failing to work together to successfully to respond to a future recession.

Assess. We need to first assess which risks we are subject to. For most local governments, the most salient risks will be recessions and natural disasters like earthquakes, hurricanes, tornados, wildfires, floods, extreme snowfall, etc. There is also the specter of man-made disasters such as hazardous material spills or the closure of a major employer/tax producer.

Next, we need to assess the likelihood and potential magnitude of these risks. There are many potential sources of data to examine, including:

- The local government's own experience.
- The experience of other local governments where extreme events have occurred.
- National institutions that track data about extreme events. The United States Geological Survey has data about earthquake likelihood, for instance.
- Staff judgment. Of course, we must take steps to counteract the shortcomings of human judgment, as we described earlier. For instance, knowing that human judgments are typically 50 percent too narrow, as noted in the example described earlier, GFOA doubled the range of the fire department's estimates to complement the data we had. You can also break estimation problems down into very small parts that are easier for staff to estimate and then add these small estimates together.

GFOA has developed a quantitative model of the likelihood and magnitude of potential risks, covering a ten-year period. A relatively long timeframe is necessary because many risks governments are concerned about occur infrequently, so a ten-year timeframe provides a better opportunity to see the potential effects. The model also assesses the combined effect of all the risks the government faces.

The combined effect of the risks a government is subject to has to be considered because the combined effect can look very different from each risk in isolation.

Augment. The third part of Triple-A is about raising our expectations of risk and making sure we don't underestimate risk by getting distracted by "average" numbers. The key is thinking in probabilities.

GFOA uses a technique called "Monte Carlo analysis" to build probabilistic models. This is the same technique used by insurance companies, aerospace manufacturers, and other industries that require a detailed understanding of risk. This method has been around since the 1950s, but up until recently it required powerful computers and specialized software. Now it now can be used by anyone who has access to Microsoft Excel, thanks to the work of ProbabilityManagement.org, which has developed open-source technology that allows Monte Carlo to run on Excel with no macros and no add-ins. Monte Carlo simulates thousands of possible versions of the future. We can then examine those scenarios to see how often different levels of damage occur. For example, if we run 1,000 scenarios, and in 100 of these scenarios a local government incurs $20 million or more in damages within five years, then there is a 10 percent chance (100 in 1,000) of incurring at least $20 million in damages within five years. Monte Carlo analysis allows us to easily see and analyze the more extreme potential outcomes.

Knowing the chances of incurring different amounts of damages allows a local government to judge its appetite for risk and size its reserve accordingly. For example, if there were only a 1 percent chance of incurring risks totaling $50 million or more in ten years, most local officials would probably be comfortable with keeping reserves at less than $50 million. As we get into less extreme scenarios, public officials

Exhibit 1: Risk Analysis Curve

A risk analysis shows how confident this city can be that a given amount of reserves is sufficient to withstand the risks the city faces over a 10-year period.

must consider their appetite for covering risk by accumulating more reserves versus spending on current services or lowering taxes. Some officials use this kind of analysis to consider the value of spending on projects to make their community more resilient against extreme events.

The results of a Monte Carlo analysis can be shown as a curve, much like the one in Exhibit 1. It shows the level of confidence a hypothetical city can have that its reserves are sufficient to withstand the risks to which the city is subject over a 10-year period. For example, $33 million would give the city 85 percent confidence. City officials are then able to debate and discuss how much risk they are willing to assume versus how much money they are comfortable having in reserve. It is notable that this curve, like in all risk analyses that GFOA has developed, begins to turn more sharply upward as we move to the right. This happens because as we move to right we cover increasingly extreme and catastrophic possibilities in order to have confidence that reserves will be sufficient.

> To understand risks, you need to quantify them.

The upward turn of the curve shown in Exhibit 1 implies that a local government needs more and more money to gain more confidence as we move right along the curve. At some point, then, it becomes cost-ineffective to rely on reserves to cover risk. This highlights the fact that

a good risk-management strategy must look beyond reserves and consider other tools like insurance, short-term financing, or investing in preventive strategies or strategies to make the community more resilient.

A quantitative risk model, like those GFOA builds, also has the advantage of being flexible in accommodating other variables that might influence a local government's reserve strategy. Examples of such variables include:

> The combined effect of the risks a government is subject to has to be considered because the combined effect can look very different from each risk in isolation.

- **Ability and Willingness to Cut the Budget in Response to Unexpected Circumstances.** Having the flexibility to reduce budgets midyear provides another source of potential funding to respond to extreme circumstances. A model can show how a willingness to cut the budget by some amount before using reserves would affect the ability of a government to maintain its desired level of reserves.
- **Minimum Acceptable Reserves.** Many governments would find it unacceptable for their reserves to reach zero or anything close to it. A model could therefore be built to express the probability that reserves would reach a minimum acceptable amount. For instance, that amount might be the minimum necessary to maintain the government's current bond rating.
- **Effects of Climate Change.** We saw earlier that a quantitative model often relies on historical data to develop the probability and magnitude of extreme events. However, historical data might understate the risk from natural disasters like floods, wildfires, or hurricanes because global climate change may make these events potentially more frequent and/or severe. A model could provide an option to augment the probability and magnitude suggested by the data.

YOUR NEXT STEPS

If you'd like to get started with stress testing your reserves, GFOA offers three options:

- **Basic.** GFOA offers a simple, non-quantitative spreadsheet that is available for free at gfoa.org/RiskAnalysisTemplate. You will find the Excel download highly ranked on your search results. Though this basic spreadsheet does not provide the analytical strengths outlined in this article, it does have the advantage of being very easy to use — no math skills needed. Many local governments have found this sheet helpful for starting a conversation about the sufficiency of their reserves.
- **Intermediate.** GFOA performed a risk analysis for the City of Colorado Springs, Colorado, and published it as a free report that is available at gfoa.org/ColoradoSprings. The analysis used in the report is quantitative but not probabilistic. So, the report does not provide the nuanced analysis described in this article, but some governments have copied the method.
- **Advanced.** You can obtain the same toolset GFOA uses to perform Monte Carlo risk analysis at ProbabilityManagement.org and start building your own models. GFOA will publish more details about how to use this form of analysis in the coming years as more and more governments gain experience with it.

CONCLUSIONS

In conclusion, a local government must carefully think about the risks it faces to find the size of reserves that is right for it. An analysis that considers both the probability and the magnitude of the risks your government faces will provide the most complete perspective on risk. This will help your community find balance when it comes to using its limited resources to provide protection against an uncertain future versus providing services today.

Notes

1. Doug Hubbard. *The Failure of Risk Management* (Wiley, 2009).
2. This issue is discussed in more detail in: Sam Savage. *The Flaw of Averages* (Wiley, 2012).
3. Spyros Makridakis, Robin Hogarth, Anil Gaba. *Dance with Chance*. Oneworld Publications. 2009.
4. See ProbabilityManagement.org.

SHAYNE KAVANAGH is GFOA's senior research manager. He can be contacted at skavanagh@gfoa.org.