RISK MANAGEMENT

The power and practicality of simulation

Simulation analysis no longer requires a mainframe, a team of programmers, and plenty of effort and patience. Last year, managers of a cogeneration plant used a standard PC and standard spreadsheet tools to simulate the plant's forward fuel price risk in just a few minutes

By David C. Rode, Steve R. Dean, PE, and Dr. Paul S. Fischbeck

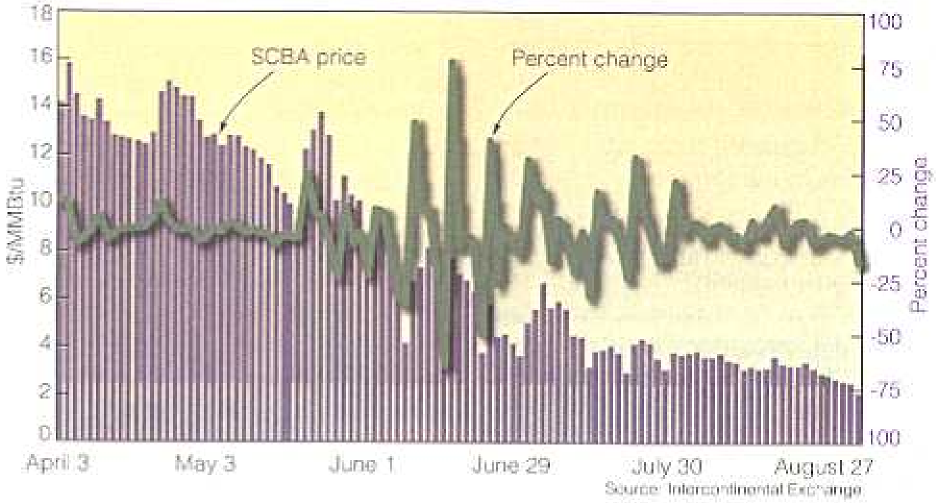
Financial risk managers routinely use computer simulations to weigh options and quantify the likely impact of decisions. Why, then, has simulation not made similar inroads in corporate and project finance, two fields constantly on the lookout for better tools for understanding and managing uncertainty?

One reason is the common misconception that simulation is so time-consuming and expensive that only "big boys" can afford to use it. But the huge improvement in microcomputers' price/performance ratios over the past two decades has invalidated that argument; today, the average desktop PC has more processing power than most mainframes had only a few years ago.

Another reason simulation hasn't caught on is its unfamiliarity. Before the PC revolution, the word "simulation" brought to mind a vision of white-smocked engineers modeling complex processes like fluid dynamics or long-term weather patterns. Now, however, considerable insight into the future can be gained even from simple, easily implemented models. Recognizing that that's the case is the first step business types must take to develop a familiarity and comfort level with simulation.

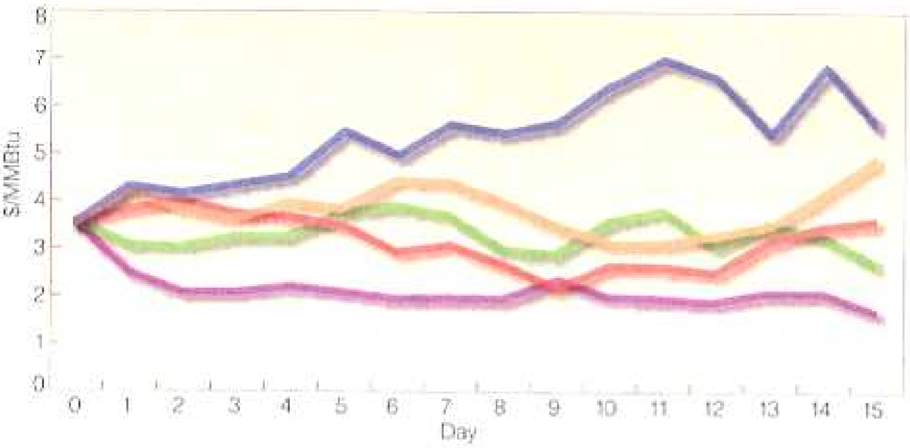
To illustrate that simulation can indeed provide quantitative answers to real-world "what if" questions quickly and easily, the remainder of this article examines how the managers of a 30-MW gas-fired cogeneration plant in California used it to model the plant's forward fuel price risk. It's worth noting that one reason the managers turned to simulation was a severe time constraint. The plant operated as a qualifying facility (QF) to San Francisco-based Pacific Gas & Electric

1. Southern California border natural gas prices



Source: Intercontinental Exchange

2. Five sample price paths



Co. (PG&E), which had recently declared bankruptcy. Deadlines imposed by the bankruptcy court in effect required the managers to figure out—in minutes—the impact of a multiplicity of possible scenarios that were to unfold over the next 15 days. In the past, that would have been impossible—but simulation makes it feasible now.

Seizing an unexpected opportunity

The California energy crisis of 2000/2001 posed problems for all QFs. But it also presented opportunities. In an effort to mitigate the crisis, the California Public Utilities Commission decided to allow QFs to modify their power purchase agreements (PPAs) with utilities. What that required a gas-fired QF to do was sign a five-year, fixed-price energy contract with its utility, and a fixed-price contract of corresponding term with a gas supplier.

For many QFs, their ability to enter into fuel contracts (credit issues aside) hinged on bankruptcy court approval of the PPA. Because the terms of natural gas contracts varied on nearly a daily basis, it made little sense for a QF to choose or even seek a supplier before the bankruptcy court ruled on the PPA. For many QFs, these were "life or death" decisions; if the terms were unfavorable, many faced the possibility of having to shut down.

But that wasn't the only problem facing the managers of the reference plant. After PG&E defaulted on its payments to its QFs, the facility had no choice but to stop paying its natural gas suppliers, and that hurt its creditworthiness. What's more, once the bankruptcy court approved the terms of its new PPA, the facility had just 15 days—in September 2001—to finalize an agreement with a new fuel supplier.

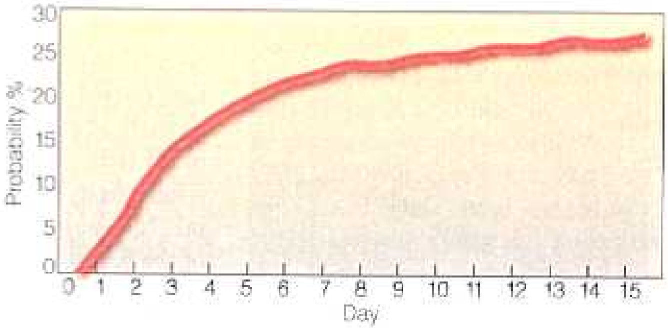
With time in short supply, the plant's managers considered their options:

- Lock in a gas contract immediately at the current market price.
- Wait and seek other suppliers in the hope of getting a better price.
- Purchase a hedging contract while seeking out additional suppliers.

While taking the time to search for better terms has clear benefits, the extreme volatility of natural gas prices raised the risk that if gas prices rose beyond a certain level, the facility's output would be priced out of operation. Although hedging is an obvious possible solution, it was ruled out in this case because of its cost and the imperfect nature of the plant's hedge. Natural gas futures are based on Henry Hub prices, but the facility's exposure was to Southern California Border Average (SCBA) prices. Although the two normally trade in lock step with each other, transmission constraints in Southern California had caused the parity between the two to break down. At the time, SCBA prices were substantially higher than Henry Hub prices and the correlation between them had dropped measurably. Fig. 1 illustrates the daily changes in SCBA prices from April 2001 through August 2001. The annualized standard deviation of daily price changes during this period was an astonishing 275% (about 10 times the typical level for individual stocks).

At the beginning of the 15-day period, the available contract was priced at \$3.50/million Btu (MMBtu). The facility could operate profitably at any price below \$4.25/MMBtu. Naturally, the owners of the facility wanted to obtain the best possible price for gas, but were not so intent on profit that they would risk shutdown if the 15-day period elapsed without a feasible contract in place.

3. Probability that natural gas price exceeds \$4.25/MMBtu



To make any reasonable decision, however, the owners needed to understand the probability of the underlying event occurring. The main question they had to answer was: What is the likelihood that natural gas prices will rise above \$4.25/MMBtu and force them out of the market?

In addition, if they did decide to search for a better price, there was the risk inherent in extending gas contract negotiations "just one more day" in the hope of a better deal. So a second question was: What is the incremental risk of waiting that additional day? Those are questions that could be answered easily by simulating the facility's exposure. Yet the concern was that any analysis had to be done in a matter of hours or it would be too late.

The analysis

The heart of the analysis, therefore, was reduced to determining the probability that natural gas prices would rise above the threshold for profitable operation during the 15-day period. The question was answered by simulating the evolution of natural gas prices over the next 15 days and calculating what percentage of the simulated prices exceeded the threshold on a given day. Having simulated these price paths, a multitude of other relevant questions could also be answered

4. Simulated day seven prices

(including the value and risk of extending negotiations by an additional day).

It's important to realize that the simulation results do not mandate a specific decision path. Rather, they allow managers to be better informed and to better exercise their discretion in determining strategy. Two managers may look at the same simulation results and reach different conclusions for a variety of reasons, not the least of which may be their tolerance for risk.

In this example, it was assumed that natural gas prices follow what is known as a "mean-reverting random walk"—a common assumption for commodity prices. Standard spreadsheet tools were used to estimate the parameters of this model from historical data. Having specified the underlying process for natural gas prices, the simulation was quickly implemented in the same spreadsheet environment. Then, to examine the impact of a wide variety of possible events, the simulation created 5,000 possible 15-day scenarios—a computational effort that took all of four seconds on a modern PC. Fig. 2 illustrates the first five such series, each of which represents a particular possible outcome. Naturally, some outcomes are more likely than others, so any substantive conclusions can be drawn only after observing a large number of these iterations.

It should also be emphasized that the plant's managers were not forecasting a specific price for natural gas over the next 15 days. Rather, they were measuring the possible paths natural gas prices might take if they behaved over the next 15 days as they had over the previous four months. According to this analysis, by the 15th day there was a 27% probability that natural gas prices would exceed the $4.25/MMBtu threshold, and therefore roughly a one-in-four chance that a costly shutdown would have to take place (Fig. 3). Having performed the simulation, this calculation was trivial. It involved counting how many of the 5,000 iterations involved day 15 prices that were greater than $4.25/MMBtu. In this model, 1,365 out of the 5,000 (27.3%) iterations showed such a relationship.

Thus far, we have provided an answer to the first question: What is the probability of exceeding the threshold? The second question involved how the risk would change on a day-by-day basis should the managers decide to continue to search for a better gas price. In other words, the initial analysis was done from the perspective of someone at day zero, making a decision at day zero.

The simulation data, however, can be used to analyze future decisions as well. Suppose that the managers, thinking ahead, wondered what they should do if they found themselves at day seven with prices above $4.25/MMBtu. More specifically, the question was: What is the likelihood of returning to a below-threshold level by day 15—or even of returning to a level below the starting point ($3.50/MMBtu) by day 15? Fig. 4 illustrates the answers, which were obtained from the original simulation data—no additional modeling was necessary. The probability that day 15 prices would be less than $4.25/MMBtu given that day seven prices were greater than $4.25/MMBtu is 37% (and 19% for being less than $3.50/MMBtu).

Conclusions

Informed by this analysis, the plant's investors decided that they would accept the risk of waiting up to two days (that is, they were unwilling to accept more than a 10% probability of shutdown) in order to try and negotiate a better price. In the end, the facility was able to reduce the price it paid for natural gas on a multi-year contract by roughly $0.10/MMBtu—a substantial return on the minimal analytical effort involved.

Managers are routinely confronted with decisions that would benefit from rigorous analysis of the uncertainty surrounding them. However, those decisions must often be made under significant time pressure. The perception that simulation analysis is an arcane, time- and resource-intensive methodology is misleading. Simulation analysis can be scaled from large to small projects and, properly implemented, can be timely and extremely informative. In fact, the reward-to-effort ratio for most simulation analyses is very favorable because of its flexibility and the wealth of information available in the simulation output. Substantial insight can be realized—quickly and cost-effectively—through the incorporation of simulation methods into managerial decision-making. ■

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