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Optimizing Harry Markowitz

By Laurie Kaplan Singh
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With the publication of his simply titled dissertation, "Portfolio Selection," 55 years ago, Harry Markowitz, a doctoral candidate in economics at the University of Chicago, presented the investment world with a new paradigm for allocating capital among risky assets. He also laid the foundation for work by William Sharpe, then a Ph.D. candidate at the University of California at Los Angeles, that led to their development of modern portfolio theory -- and earned both men, along with economist Merton Miller, the 1990 Nobel Prize in Economics.

In "Portfolio Selection," which appeared in the March 1952 *Journal of Finance*, Markowitz introduced the concept of the efficient frontier: the curve representing all portfolios that maximize the expected return for a given level of risk, or, alternatively, minimize the risk for a given level of expected return. Markowitz presented an algorithm for constructing optimal portfolios based on estimated returns and risks and the correlations between securities. His mean-variance optimization model, or MVO, has been an indispensable tool for allocating capital among risky assets for more than half a century.

Nonetheless, academics and investors have been debating the practical merits of the MVO methodology for decades. Now a father and son team -- Richard Michaud, president and chief investment officer of New Frontier Advisors, and Robert Michaud, managing director of research and development at the Boston firm -- have developed what some major money managers see as a significant enhancement of Markowitz's algorithm.

About 20 firms, including Atlantic Trust Private Wealth Management and Wachovia Securities, have licensed the Michaud model. "Our solution is very simple but very powerful," contends Richard, the father, winner of a Graham and Dodd Scroll award for financial writing for his work on optimization and an editorial board member of the Financial Analysts Journal. The Michauds have patented their so-called resampled efficiency optimizer and portfolio rebalancing technology.

To be sure, not all academics and practitioners are convinced that the Michauds have come up with a better mousetrap. Yet Markowitz himself has acknowledged the significance of the Michauds' work. "The Michauds have made an important suggestion about how to [incorporate the fact that] estimates are uncertain, and they have stimulated a good discussion," Markowitz tells *Institutional Investor*.

In a study, "Resampled Frontiers Versus Diffuse Bayes: An Experiment" (*Journal of Investment Management*, Fourth Quarter 2003), Markowitz and Nilufer Usmen, a finance professor at New Jersey's Montclair State University School of Business, compare Michaud resampling with the traditional Markowitz mean-variance-optimizer model, using improved inputs. Markowitz and Usmen use a statistical technique known as "Bayes with a diffuse prior" to adjust the estimates of risk and return for uncertainty. "We wanted a formal procedure that takes into account the sampling error in historical averages," Markowitz says.

The Markowitz and Usmen experiment revealed that the Michauds' resampled efficient frontier produces portfolios with more diversified collections of stocks and better returns for a given level of risk, or the converse. "Much to our surprise, the Michaud methodology did better than ours," says Markowitz.

Of course, the Markowitz-Usmen study is but one experiment. Some academics and practitioners contend that a different Bayesian approach to generating the inputs would produce a different conclusion.

A recent working paper by Campbell Harvey, a finance professor at Duke University, and co-authors John Liechty, an assistant professor of marketing and statistics at Pennsylvania State University, and Merrill Liechty, an assistant professor in the department of decision sciences at Drexel University, shows that a minor change in the estimation procedure used in the Markowitz-Usmen experiment can produce the opposite result. "Our study shows that the Bayes technique beats resampling at lower levels of risk," Harvey says.

The Michauds' system is meant to address a weakness of the Markowitz optimization algorithm: its insensitivity to estimation errors. The problem with the Markowitz algorithm, Richard Michaud explains, has to do with how the computer uses the information plugged into it.

"As humans, we see the data as an estimate," Michaud says, "but the computer-driven optimizer assumes an unrealistic accuracy in the estimation of inputs." Inputs in this case consist of estimated returns, risk and asset correlations. Because the classic Markowitz optimizer operates on these inputs as if they were known with certainty, the MVO algorithm is highly sensitive to estimation error. Its recommended portfolios tend to have heavy concentrations in one or two asset classes.

"The classic Markowitz optimizer generates an asset mix that's unsuitable for our clients," says Michael Jones, a managing director in advisory services at Wachovia Securities in Richmond, Virginia.

Pioneering studies of the practical limits of the Markowitz framework date to the early 1980s, when J.D. Jobson, curently associate dean of the MBA program at the University of Alberta, and Bob Korkie, professor emeritus of finance at the university, concluded that the certainty that the Markowitz optimizer attaches to input estimates tends to make the solutions highly sensitive to small changes in those inputs.

Investors who use mean-variance optimization attempt to counter its tendency to generate concentrated portfolios by adding constraints and improving the inputs, often using sophisticated statistical techniques. "We've had to add so many constraints that the process is no longer rigorous," Wachovia's Jones says. Adds Jeffrey Thomas, CIO of Atlantic Trust in Boston, "The fix negates the model's value."

Imposing too many constraints is "torturing the optimizer," says Richard Michaud. "If you torture it enough, it will tell you exactly what you want."

Investors have also sought to address the estimation problem by using statistical methods to generate better inputs. One of the most widely used methods was developed in the early 1990s by thenGoldman, Sachs & Co. vice chairman Fischer Black (of the Black-Scholes option pricing model) and Robert Litterman, a Goldman Sachs managing director. Their Black-Litterman model plugs assumed-to-be-efficient market portfolio weights into the Sharpe-Lintner capital asset pricing model (a formula that equates the expected return on a security to the risk-free rate of return plus a risk premium) and solves for the starting inputs.

"The results are intuitive because Black-Litterman is grounded in modern portfolio theory," says Thomas Idzorek, director of research at Ibbotson Associates in Chicago, which uses a proprietary resampling algorithm. "The inputs can then be fed into a traditional Markowitz optimizer or a resampled optimizer, such as the Michaud framework."

The Michauds' solution to the shortcomings of the Markowitz algorithm was to add the element of uncertainty. The father-and-son team pursued a Monte Carlo simulation to forecast multiple sets of inputs (i.e., return, risk and asset correlations), as proposed by Jobson and Korkie in 1981 and by Philippe Jorion in 1992.

The Michauds feed the Monte-Carlo-generated inputs into a Markowitz mean-variance optimizer and generate multiple efficient frontiers -- one for each set of inputs. They then collapse these into a single efficient frontier, or optimal portfolio.

"We generate the optimal portfolio under multiple scenarios, and we take the average," explains the younger Michaud. "The average is very robust; it's almost always close to the right answer."

Many practitioners and academics praise the Michaud model as an advance over Markowitz's methodology. "It tends to produce portfolios that are more intuitive," says Atlantic Trust's Thomas. Users are less tempted to preconstrain, he adds, and the Michaud model is less sensitive than the Markowitz optimizer to changes in input estimates. Ibbotson incorporates its own version of the Michaud resampling algorithm into its flagship portfolio analysis software product, Encorr. "Resampling overcomes the weakness of traditional mean-variance optimization and leads to better-diversified portfolios," says research director Idzorek. Bernd Scherer, head of advanced applications at Deutsche Asset Management in Frankfurt, says that "Michaud resampling appears to produce better portfolios than traditional Markowitz optimization." But he is troubled that no one seems to fully understand why.

Another weakness of the Michaud resampling model, according to Deutsche's Scherer, is that it outperforms the Markowitz optimizer only when a long-only constraint is applied. When the model is allowed to recommend both long and short allocations, he says, the Michaud frontier coincides perfectly with the Markowitz efficient frontier.

"A methodology that claims to effectively deal with estimation error should work in all circumstances," Scherer argues. He says that Michaud resampling defaults to the Markowitz optimization in the one circumstance where investors need the improved methodology the most: when they can go long and short without limits. "Michaud has made a significant contribution, but it's [only] the first step," says Duke's Harvey. "More work needs to be done to explicitly address uncertainty in asset allocation decisions."

The perfect optimizer, like the perfect portfolio, doesn't exist. Yet.