Health Capital Topics ©
Volume 9
Issue 12
December 2016
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Statistical Methods Utilized in Valuation Reports: Monte Carlo Simulation Analysis (Part Six of a Six-Part Series)

The *Monte Carlo Simulation Analysis* (MCSA) is a statistical technique that produces several hundreds of thousands of simulated scenarios by harnessing the ability of computers to quickly complete repetitive tasks.[1] As an ideal process for determining "*what-if*" scenarios, valuation analysts may utilize MCSA in situations where there are several distinct scenarios and/or unknowns.[2] This simulation-based method may be used to evaluate estimators and goodness-of-fit statistics, which then may be utilized in identifying potential problems with a financial model or alleviating problems inherent to the model, such as misspecification or sample size, among others.[3] MCSA methods are theoretical and based solely on empirical evidence,[4] and often serve as a last resort when other analytical methods fail.[5] The basic goal of an MCSA model in a valuation analysis is to determine the probability, in an informed manner, of those factors that affect the economic benefit accruing to the owners of an asset.[6] From those randomly determined factors, the analyst then determines the economic benefit that would accrue. This final installment of this six-part *Health Capital Topics* series on statistical methods utilized in valuation reports will discuss, at a high level, the basics of the MSCA technique, how MCSA can inform healthcare valuations, and the limitations that analysts should keep in mind when utilizing this technique.

Although there is no uniform MCSA method, the basic structure of simulation procedures, including MCSA, typically take the following form: (1) model a system as some probability distribution; (2) randomly sample from the probability distribution; and, (3) compute any statistics of interest based on the goal of the analysis (e.g., sample mean, sample variance, or other specifications).[7] In short, an analyst creates a "*controlled condition*" in which the statistics of interest may be inferred from a larger, theoretical dataset where understanding the probability distribution utilized is key to understanding the behavior of a statistic of interest.[8] The principles of probability distribution rely heavily on statistical properties such as the *Law of Large Numbers*, which states that as the size of a sample increases, the expected value of the sample mean approaches the population mean (for information regarding descriptive statistics, please reference the August 2016 *Health Capital Topics* article entitled, "*Statistical Methods in Valuation – Descriptive Statistics*").[9]

As an example, consider revenue for a healthcare enterprise, which is most often the product of: (1) output (e.g., procedure volume); and, (2) reimbursement per unit of output.[10] These factors can be considered the underlying random factors that drive the revenue of a healthcare enterprise.[11] Therefore, to apply an MCSA technique to a revenue projection, the analyst would assume a probability distribution for both the procedure volume and the reimbursement per unit of output.[12] One such selection could be to assume that both variables are log-normally distributed, i.e., that the percent change in the variables are normally distributed with a mean equal to the long-run trend and variance equal to the historically observed variance.[13] The analyst would then randomly select (more precisely, the computer program utilized for the MCSA would select) randomly a value for the growth rates in output and reimbursement from a population with the mean and variance parameters.[14] A single iteration would then be the last period reimbursement increased by the randomly selected growth rate times the last period output increased by the randomly selected growth rate for the output.[15] This process would be repeated over a sufficiently large number of scenarios to result in a number of possible revenue outcomes, the average of which would be the most probable revenue (given the distributional assumptions noted above).[16] A similar process could be undertaken to project a number of possible economic expense burdens necessary to support the number of different revenue amounts already calculated.[17] The analyst could then calculate the difference between these two projections as the residual income that would accrue to the owner of the asset. This residual amount could then be averaged and discounted to arrive at the value, as of the valuation date, of the right to ownership of the asset.[18]

There are several limitations associated with the MCSA, both within and outside the healthcare industry. One of the main shortfalls regards the scope of available data; MCSA is limited by the amount of historical data available to parameterize the underlying random factors affecting value. With a small dataset, the variability of the underlying random factors may be too large to provide an expectation without a wide margin for error, and it may be more appropriate to utilize an analytical method. The quality of analysis may rely on the quality of data available (for more information see Part Four of

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this series: *"Data Sets and Samples"*).[19] Another limitation to MCSA is the necessity to assign a particular probability distribution to the underlying factors. This requires making an assumption regarding the nature of the data generating process that produces each of the random underlying factors affecting value.[20] In light of this limitation, the analyst should be careful to select a distribution that is sensible for the given underlying variable.[21] For example, a normally distributed random variable can (with a non-zero probability) take on any value from negative infinity to positive infinity. Reimbursement, on the other hand, cannot be below zero (and in all practical applications cannot be zero). Therefore, assigning a normal distribution to reimbursement would be inappropriate; consequently, an alternative distribution (e.g., a log normal distribution) should be selected. Another limitation of MCSA is that the technique requires a significant level of computer competency to properly apply the methodology.[22] Some user-friendly additions to familiar software packages (such as the *Crystal Ball* add-in for Microsoft Excel) have been developed, but caution is advised in using *black-box* programs without understanding the particular limitations of the software utilized. Inadvertent errors may occur if the output from these programs is not sufficiently understood by the valuation analyst.

This last installment concludes the six-part series discussing the basic background and applications of five (5) statistical methodological approaches commonly utilized in valuation: (1) descriptive statistics; (2) coefficient of variation; (3) data sets and samples; (4) regression analysis; and, (5) Monte Carlo methods.

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1 "Monte Carlo Simulations: Advanced Techniques" By Jason Andrews and David Dufendach, Portland, Oregon, Business Valuation Resources, 2013, p. 6.
2 *Ibid*.
3 "Monte Carlo Experiments: Design and Implementation" By Pamela Paxton, et al., Structural Equation Modeling: A Multidisciplinary Journal, Vol. 8, No. 2 (August 2001), p. 288.
4 *Ibid*, p. 288-289.
5 "Monte Carlo Methods" By Dianne P. O'Leary, University of Maryland, 2008, https://www.cs.umd.edu/~oleary/c660/660montehand.pdf (Accessed 7/15/2016).
6 "Healthcare Valuation: The Financial Appraisal of Enterprises, Assets, and Services" By Robert James Cimasi, MHA, ASA, FRICS, MCBA, CVA, CM&AA, Volume 2, Hoboken, NJ: John Wiley and Sons, 2014, p. 57-58.
7 "Introduction to Monte Carlo Simulation" By Robert L. Harrison, American Institute of Physics Conference Proceedings, Vol. 1204, (January 5, 2010).
8 Pamela Paxton, August 2001, p. 289, 291.
9 "The Law of Large Numbers" Stat Trek, Statistics and Probability Dictionary, http://stattrek.com/statistics/dictionary.aspx?definition=law_of_large_numbers (Accessed 8/1/2016).
10 Cimasi, MHA, ASA, FRICS, MCBA, CVA, 2014
11 *Ibid*, p. 111.
12 *Ibid*.
13 *Ibid*.
14 *Ibid*.
15 *Ibid*.
16 *Ibid*.
17 *Ibid*.
18 *Ibid*.
19 "Statistical Methods in Valuation Analysis: Data Sets and Samples (Part Four of a Six-Part Series)" Health Capital Topics, Vol. 9, No. 10 (October 2016).
20 "Applied Econometric Time Series" By Walter Enders, Hoboken, New Jersey: John Wiley & Sons, Inc., 2010, p. 204.
21 "A Guide to Econometrics" Peter Kennedy, Fifth Edition, Cambridge, Massachusetts: The MIT Press, 2003, p. 35.
22 "Quantitative Methods for Investment Analysis" Richard A. DeFusco, CFA, Dennis W. McLeavey, CFA, Jerald E. Pinto, CFA, David E. Runkle, CFA, Second Edition, Charlottesville, VA: CFA Institute, 2004, p. 266

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